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Engineering News-Record

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Heavy Highway Cuts Sluiced Into Adjoining Fills

By Cornelius W. Meyers

Some Lessons Learned in Building a Long Concrete Bridge

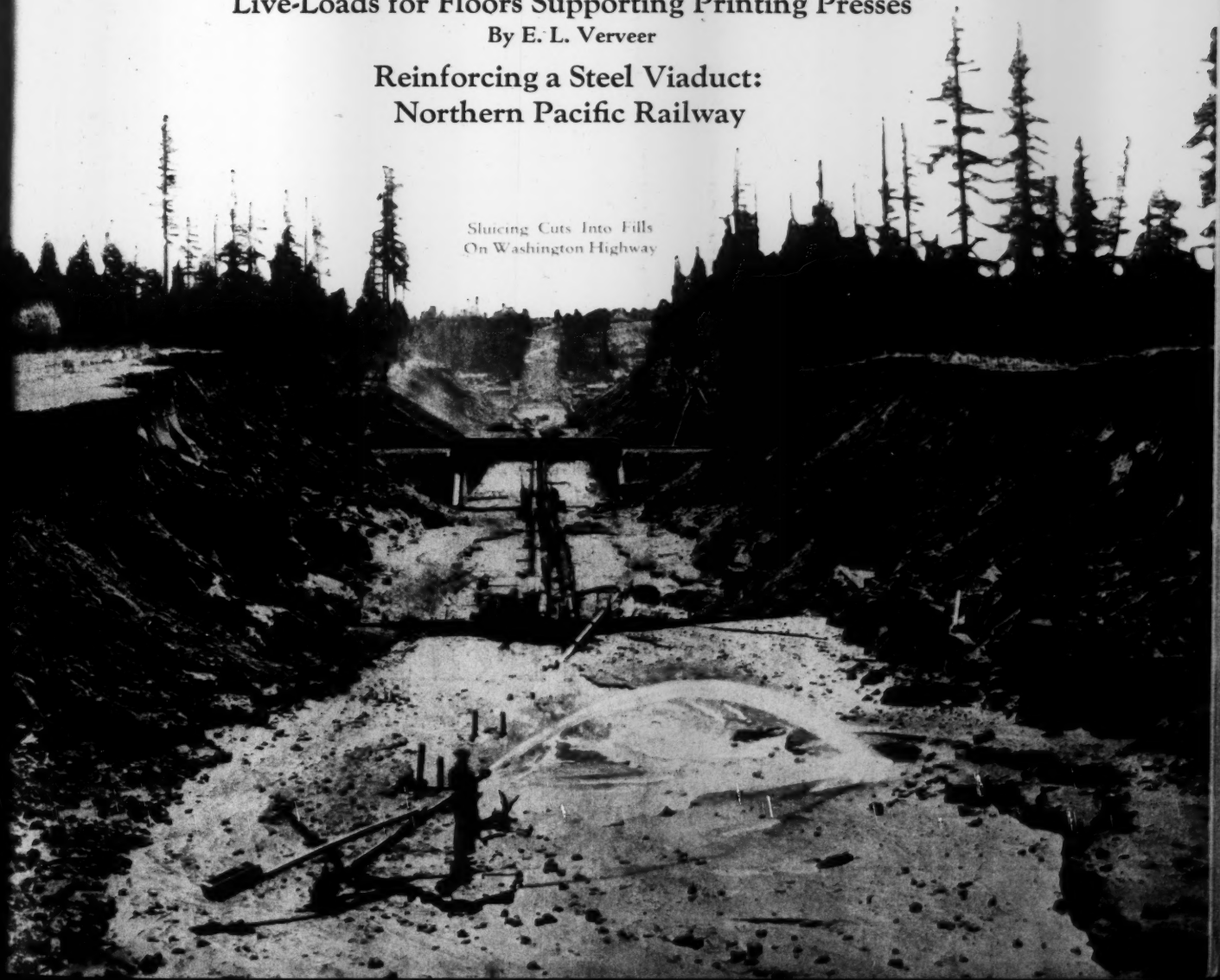
By John F. Greene

The second article on the Robert St. bridge

Live-Loads for Floors Supporting Printing Presses

By E. L. Verveer

Reinforcing a Steel Viaduct: Northern Pacific Railway



Sluicing Cuts Into Fills On Washington Highway

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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FRANK C. WIGHT
Editor

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An Engineer Governor

FRANK C. EMERSON, the state engineer of Wyoming, has been elected governor of his state. So far as the records can be traced, he is the first bona-fide civil engineer to head one of our commonwealths. The present governor of Washington was an engineer officer during the war but he is primarily a lumberman and not a technical man, and James Hartness, a distinguished mechanical engineer and once president of the American Society of Mechanical Engineers, served some years ago as governor of Vermont. Mr. Emerson, though, is by education and practice a civil engineer, and one long conversant with the engineering problems of the state he is now called upon to serve in executive capacity. It has long been a belief of engineers that the problems of government are peculiarly susceptible to solution by the application of engineering principles and that if an engineer could be found with enough political sense to find his way through the mazes of officialdom and enough understanding to remember always that materials and methods do not dominate human behavior, he would be an ideal candidate for leadership in government. So few engineers direct their efforts in this direction that we have little data by which to confirm this opinion. Mr. Emerson has furnished the material for a service test, and one in the part of the country where engineering knowledge and experience are particularly valuable. He has the good wishes and the high hopes of all the profession in the experiment.

Half-Knowledge

MANKIND'S deep-rooted faith in the stability of the earth expressed itself many centuries ago in the old term "terra firma." Happenings which momentarily shook this faith, as earthquakes and landslips, exercised a peculiarly terrifying effect, the more so as they were wholly mysterious in origin and causation. The old terror as well as the old mystery still persists in the matter of earthquakes. Landslips, on the other hand, have to some extent come into the field of tangible knowledge and engineering control, and so are less feared. In the case reported this week from Oakland, drainage methods were applied quite successfully to checking a large hillside creep, just as in a number of prior instances, for example the similar creep at Bellevue, near Pittsburgh, a dozen or more years ago. That excess water is the direct cause of most slides, though not of all, has come to be well understood. Unfortunately there are many types of slides, and water does not act quite the same in each of them. We still know very little of slides as a class, in short; but we do know that potentially they affect a large part of the earth's surface, as witnessed by widespread evidences of landslip topography. For both reasons they constitute one of the most fertile fields for investigation in civil engineering. At present such study is under the handicap of insufficient underlying knowledge of soil action. Progress in soil knowledge is continuous and accelerating, however, and it may not be long before the work can be undertaken with good promise. For the present the field remains one of half-knowledge.

Europe and Concrete Roads

THE uncertain attitude toward concrete roads held by continental European highway engineers, particularly those of southern Europe, is reflected in the conclusions, which we publish on another page, of the International Road Congress held at Milan in September. The concrete road is accepted as a reliable road structure for heavy traffic but with evident inability to get away from the notion that it requires something additional in the way of special cements or special surfacing carpets or hardeners or some particularity of construction to reduce joint dimensions, to be truly sufficient. So unaccountable is this thinking to American concrete road builders that they are puzzled how to regard it. The puzzlement is not because engineers in America are unaware that problems still exist, that concrete roads wear, that joints give trouble and that cracking occurs and, therefore, that there is need of continuous and persistent experimentation and study. Rather it is from inability to perceive why these secondary faults should be allowed so far to discount the great primary virtue of the concrete road, as a traffic carrier. There is no such attitude indicated in the conclusions concerning bituminous roads. These conclusions indicate that bituminous road practices may be improved and suggest how to bring improvement but they do not imply, as of course they should not, that, because an advance in technique is desirable, there is any doubtfulness of the merit of the general type. Interesting speculation is possible along several paths but we wonder how far the obvious discontinuity—cracks and joints—of concrete road surface may account for the uncertainty with which they are regarded in Europe.

Instruction in Economics

ECONOMICS has always been an intrinsic part of engineering, though the fact has not always been recognized as clearly as it is now. From the earliest days the engineer has had to balance the ultimate costs of the alternatives that presented themselves, and to be able thoroughly to comprehend the intricacies of such a balancing is after all the real test of an economic understanding. Of late this necessity for economic literacy has been more and more impressed on engineers, especially in their school days, so that what the good engineer used to do more or less unconsciously in the future will become a conscious part of the technical equipment. In these transition days, however, every

insistence on the importance of the economic view is worth while. Especially to be commended, therefore, is the move of the affiliated engineers of Milwaukee, noted in our news section, to inaugurate a series of lectures on engineering economics. No man was ever educated by lectures alone but the selection of speakers and subjects at Milwaukee is particularly happy and the informative value of the talks will be great. Other societies might well follow the example here set.

A Concreting Hazard

THE phenomenon of "gaining water" which every concrete worker knows and which, be it whispered, helps the contractor to endure cheerfully the dry mix exactions in many specifications is brought out excellently in the article in this issue on the Robert Street Bridge at St. Paul, Minnesota. Briefly the fact is that concrete which comes from the mixer with a very slight slump will, in the process of pouring and working, particularly in the forms where the men trample and spade one batch on top of another, "gain water," become soft, indeed often become sloppy. An explanation is not difficult to discover, in fact one is given by Mr. Greene in his account of the St. Paul bridge work, but it is the occurrence rather than the cause of the occurrence that chiefly interests the practical constructor. If he is the supervising engineer his reaction will be that of Mr. Greene and in his caution his efforts will always be to keep the mix in the forms dry to the verge of non-workability. If he is the man who is working to get the largest yardage per man unit, that is if he is the contractor, his efforts will be constantly to get more water. It is, as Mr. Greene points out, one of the most cunning of the concrete constructor's tasks to adjust this difference to secure the consistency which gives both quality of concrete and speed of placing. Unless this is accomplished the best construction engineering is not exercised. Too often the balance is not kept. Either yardage is secured at the cost of streakiness or speed is sacrificed for only a fractional improvement in quality. The discussion in the article is pertinent in illustrating this hazard of concrete construction which is seldom referred to in the literature of the subject.

Hydraulic Earth Moving

WATER is coming increasingly into use merely as an economic carrier of earth required in making fills. In this use there is no question of the sorting value of water as in hydraulic-fill dam building or of pumping because the borrow is subaqueous as in hydraulic dredge filling; instead it is the selected excavating and transporting agent where dry excavation and carriage are wholly practicable because it is economically preferable. In the highway grading operation described in this issue and again in the land grading operation described three weeks ago the function of water is essentially that of a carrier, a device receiving filling material at one place and taking it to another place where it is wanted. That in doing this there may be sorting and consolidating actions is incidental to the main service rendered. In this use of water as a carrier it is important to note how well it may be kept under restraint to produce the embankment shape and dimensions required. The road grading operation described in this issue presents several examples of control methods whose effectiveness is exceeded only by their simplicity. Both the device of undercutting the excavation slope and letting the bank cave to repose and that of bulkheading the wet fill and then after draining removing the bulkhead and letting the fill cave to the angle of dry earth repose are as neat as any which hydraulic filling practice offers us out of a plentiful store. Possibly they are not new with this operation and whether or not they are is of little moment; they demonstrate an ability to aline and shape water borne filling material which experts in hydraulicking have brought to a marvelous degree of perfection. Earth movers can well afford to examine the hydraulic earth handling methods described on another page and in the article which appeared in the issue of Oct. 21.

Higher Bridge Curbs

ANOTHER automobile has gone through a bridge railing, this time on the Connecticut Ave. Bridge at Washington. A slippery pavement, an imminent collision, quickly applied brakes, skidding, and the ordinary curbing offers no barrier whatsoever to the uncontrolled car. Fortunately in this latest case the railing held sufficiently or the car caught an obstruction in time to save it on the brink of a 90 ft. fall, but the lesson is there. Automobile travel has made a new problem in bridge design. Five-inch curbs will not hold a moving car, and the absolutely safe railing is yet to be built. Bridge engineers must give more attention to their curbs, not only in new design but in existing bridges. A foot-high barrier between roadway and sidewalk is not difficult to provide, and while it is not impassable to a skidding automobile, it comes near being so. And it is better to be slowed down six feet from the edge of a bridge than at the edge itself.

Used Equipment Values

CONSTRUCTION equipment, in itself, is plainly of major concern to all engineers and contractors. That the methods of marketing it are also important to others than the manufacturers and distributors is not so often considered. Especially is this importance manifest for used equipment which the engineer and the contractor often find it necessary to sell as well as to buy. A better knowledge of the present method of marketing used construction equipment and of the advantages and disadvantages of various viewpoints on the question should prove a healthy tonic. Articles appearing in *Engineering News-Record* during the past several weeks on the subject of trade-ins and used equipment merchandising have been published with this idea in mind.

Merchandising practices for used construction equipment seem to be entirely satisfactory to none of the interests concerned— the contractor, the manufacturer, the distributor, or the used equipment dealer. Perhaps such an attitude is inevitable. Nevertheless, the willingness of the interested parties to state their views and policies on the question of the purchase and sale of used equipment encourages the hope that some spark may be struck that will prove of value. The article this week by a used equipment dealer suggests having an appraisal made by a disinterested third party upon all used equipment offered for sale. The suggestion has possibilities, for, whether used equipment is traded in on new equipment, is sold to another contractor, is sold to a used equipment dealer, or is offered to the junk

man, some idea must be had of its real value. Blind bargaining between the buyer and the seller can easily result in an unfair price to one or to the other.

This plan of disinterested appraisal is the only plan, of the countless number proposed during the past five years to alleviate used-car merchandising ills in the automobile field, that has endured and is being operated to advantage. All the other elaborate schemes, such as having the manufacturers post current used-car prices, having dealers agree on a maximum allowance price, having a central motor mart operated in the name of the public or in securing dealer and manufacturer co-operation in other ways, have failed.

Comparisons made between merchandising practices in the used automobile and used construction equipment field are often fallacious, since different motives usually prompt the transactions. Also, there is a market for automobiles in very poor condition, while no such sales outlet exists for construction equipment that is practically worn out. But regardless of the differences between merchandising methods, the reactions of individuals, who at the same time are competitors, to any scheme of co-operative marketing are the same. In this regard, at least, the automobile and construction equipment industries can be compared. Human-relations factors have contributed largely to the failure of most of the co-operative schemes for merchandising used automobiles regardless of any inherent weakness of the schemes themselves. The same experiences would probably recur when dealing with used construction equipment.

Holding Companies and Public Ownership

AT a meeting two weeks ago at the American Academy of Political and Social Science a lady from Connecticut startled the assembly with the statement that her electric light and power bill, from a private company, was $29, whereas had she lived in Ontario under the benevolent dispensation of the publicly-owned Hydro-Electric Power Commission the same use of lighting and household appliances would have cost her but $8. In the November issue of the *Atlantic Monthly* Prof. W. Z. Ripley, continuing his pointed comments on certain corporate and financial divagations of the present day, holds up to public view the dangers that exist and lie ahead in the growing tendency to group under one large holding company, a purely financial machine, the manifold activities of many diversified and geographically widespread electric power companies. This coincidence of two really unrelated events may well prompt the user and the producer of electric energy to thought.

Professor Ripley is not an advocate of public ownership. He shows no signs of having absorbed the superficial theory that all private power production is essentially selfish and costly and that the people are being mulcted of millions of dollars, present and prospective, by their foolish reluctance to take over power production. What he does emphasize is that the domination of the private power field is in the hands of financiers whose whole trend of thought, though he does not say so in so many words, is strangely similar to that of the railroad magnates of the last century, who to their own great profit so thoroughly demoralized the transportation industry of the country that it has for twenty years been struggling to release itself from the slough of government control and popular disapproval into which it was thrust by those same financial manipulators.

Professor Ripley's citations are familiar enough and thoroughly sound. They range all the way from the uncontrovertible benefits of business and technical co-ordination to the excessive complication of financial structure which makes almost impossible any reasonable control of rates of the subsidiary producer of power and allots to the marginal, and as a rule inside, holder of holding company securities exceptional profits, at the same time storing up possibilities of future distress among thousands of small holders in case of a depression which would be reflected in reduced profits or even in losses. His charge is, in effect, that the holding company theory is essentially a financial theory in which the legal and financial mind dominates, and that type of mind is always more concerned with legalities and present profits than with moralities and future progress.

One man cannot win a battle, but if he is sufficiently shrewd and intelligent he can direct a war. Professor Ripley would be the last to claim that his recent series of articles on certain forms of financial and corporate abuse were in themselves powerful enough to effect desired reforms, but it is only testimony of how effective is truth as a weapon that these articles are beginning to force changes of public opinion which show signs of penetrating to our financial centers. The men who are directing our power production may well take this thought to heart. On the one hand they find the calm arraignment of their policies, and on the other they are blind if they do not see the rising tide of resentment, and ignorance, that is so aptly revealed in the unbalanced charges of the lady from Connecticut. Many people are coming to believe that power, particularly water power, is the prerogative of the state. Partly this obsession is due to misunderstanding of what power production really is, of the complications of production by both steam and water and the endless interweavings of transmission and distribution. To most laymen power today is a simple commodity, made by utilizing the eternal energy of moving water and by some mysterious, though simple, means transformed into the electric bulb and washing machine. But on top of this ignorance is a very real resentment at financial operations which are so complicated as to not to be understandable and therefore to be suspected.

Those who believe that government ownership of power is dangerous because it is bound to be uneconomical will have to take cognizance of this growing tendency of thought. Defeats of the public ownership movement in the West may lead to overconfidence. They must not forget that in New York an administration was returned which has consistently advocated public ownership and in so doing has had the support of the leading newspapers of the state. The movement is by no means dead and no small part of its vigor is due to the abuses that Professor Ripley is pointing out. There are, as he says, good holding companies; there are restrictions of law which make some of their obvious evils necessary; there are as yet unsolved problems of national versus state control which make some corporate ambiguities necessary. But the writing is on the wall. If the power industry does not want to follow the railroad industry into the dark shadow it had better soon begin to clean house. It might as a starter subordinate a few of its legal and financial lights to the more far-seeing, and strange as it may seem to some of these gentlemen, more social-minded engineer.

Heavy Highway Cuts Sluiced Into Adjoining Fills

Hydraulic Giant and Shearboards Used to Effect Line and Grade Improvement on Washington Road Job Where Conditions Did Not Favor Dragline or Power Shovel

BY CORNELIUS W. MEYERS
Resident Engineer, Johnson Contract Co., Portland, Ore.

A RECENT line and grade improvement project on the Pacific Highway about two miles north of Vancouver, Wash., has eliminated a score of sharp curves, reduced maximum grade from 8 to 5½ per cent and shortened the line 18 per cent in a length of 3,000 ft. These improvements were achieved by a rather bold relocation involving two deep cuts and two fills. One of the fills is 1,000 ft. long and has a height of 50 ft. The adaptation of the hydraulic sluicing method to the moving of material from the cuts to the fills is described in the following.

The material to be moved was chiefly sand and the total length through the two cuts was about 1,800 ft. This length made it impracticable to use a dragline; the required side slopes of the cuts being 1½ to 1 placed a power shovel at a disadvantage and the sandy soil was not favorable to trucking. The 5½ per cent grade was a deterrent to the use of hand dump cars although this method was considered.

In considering the hydraulic sluicing method there were also difficulties in (1) a very limited supply of water available in Burnt Bridge Creek which passed under the big fill; (2) the prohibitive cost of pumping water from a larger water supply 2 miles distant; (3) the flat grade in cut No. 1 which prevented direct sluicing of material from the cut No. 2, the upper cut, to the fill on the lower side of cut No. 1 and finally (4) the 50-ft. height in a hydraulic fill constituted a considerable risk to valuable adjoining property if any accident should occur during construction.

The contractor leased land on the downstream side of the fill and with a 5-ft. earth dam created a one-acre impounding basin on Burnt Bridge Creek that would store the stream flow and also catch all water that drained off the fill. With this plan the water of the creek was so conserved as to make it sufficient for all sluicing operations.

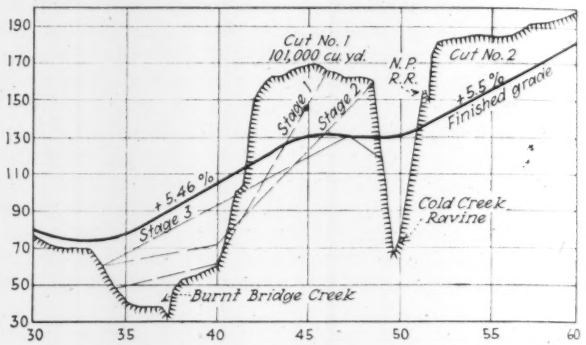


FIG. 1—PROFILE OF RELOCATED HIGHWAY

The first sluicing was on the down-hill side of cut No. 1. The giant was supplied by a 10-in. two-stage centrifugal pump with a capacity of 3,000 g.p.m. against a 210-ft. head. The material was sluiced out through a ditch which followed the successive slopes marked by stages 1, 2 and 3 in the accompanying profile, Fig. 1, as the giant was moved back. Having cut through the

FIG. 2—VIEW THROUGH CUTS AND ACROSS FILL
Material being sluiced from cut 2 beneath railroad. Curves of old location in background.

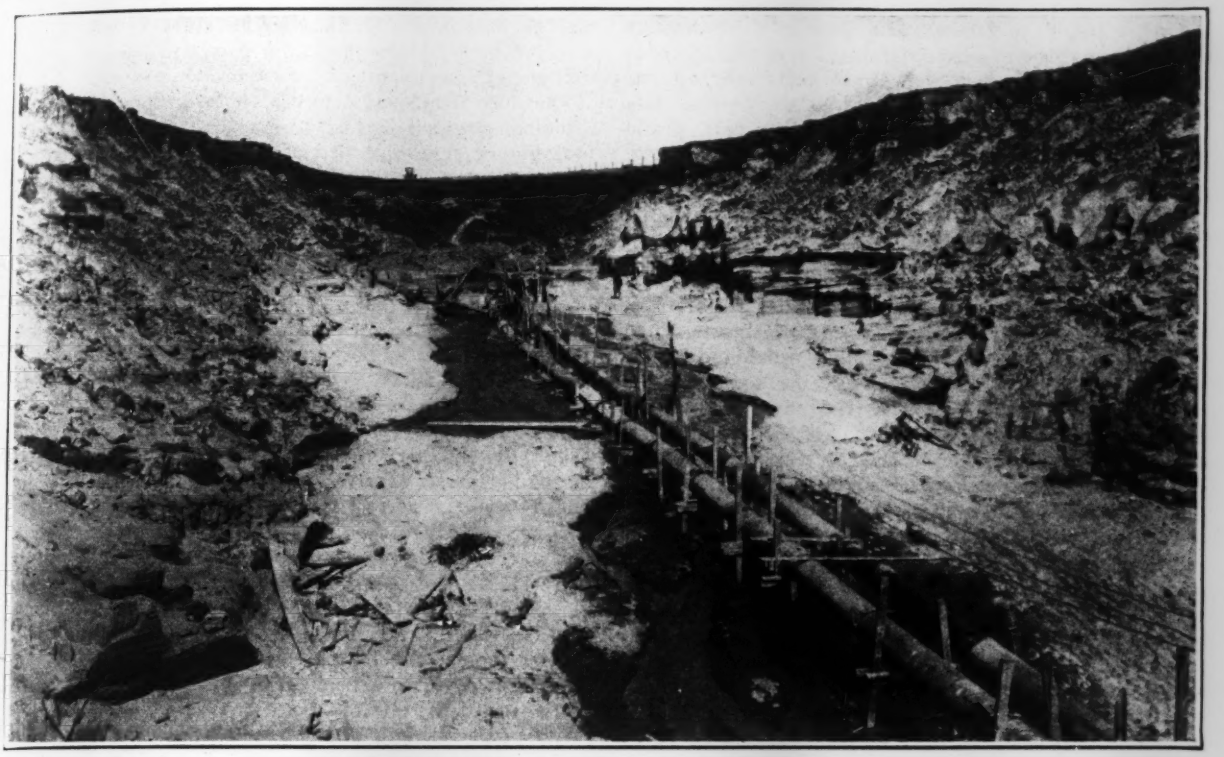


FIG. 3—LOOKING TOWARD UPPER END OF CUT NO. 1
Pressure pipe at left serves giant while line at right carries away sluiced material.

hill with the ditch, the giant began at the upper end of the cut to work down grade, widening to the full width required and sluicing the material down through the ditch into the fill below. In this process the excess depths cut by the ditch at first were filled up of course and the finished grade was close enough to the prescribed roadbed so that it could be easily finished off as required by teams and fresnos trimming up the slopes and ditches. The final operation of the giant in cut No. 1 was to sluice the material at the upper end, indicated by the shaded area in the profile, in the opposite direction to start the fill in Cold Creek ravine.

Cut No. 2, above the railroad, required different treatment because, while the Cold Creek ravine fill

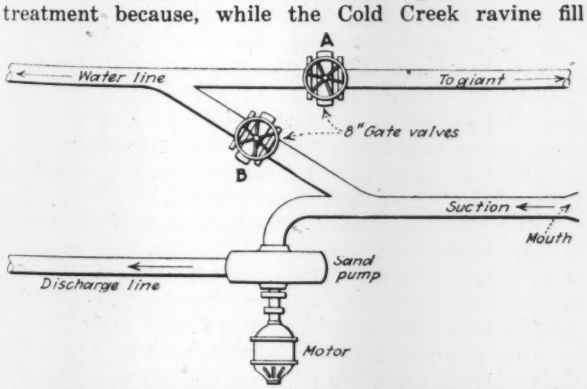


FIG. 4—ARRANGEMENT OF PUMP AND PRESSURE LINE

could be sluiced directly into place, the flat grade in cut No. 1 made it necessary to use a pipe in order to transport the bulk of the yardage from cut No. 2 to the fill below cut No. 1. Into cut No. 2 was extended the 14-in. wood-stave pipe through which the pump delivered to a 3-in. nozzle. As the material was sluiced down by the giant it was caught by plank wing walls set up across the cut and fed into a 17-in. riveted steel pipe laid down the middle of the roadway through the lower cut and out onto the big fill.

The first material sluiced under the railroad tracks went through a culvert laid on a 10 per cent grade on the road center line and about 15 ft. above highway

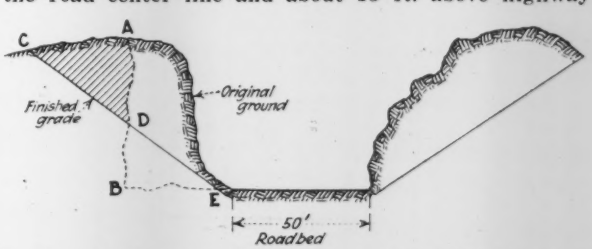


FIG. 5—*ADB* MARKS SIDE OF CUT AFTER SLUICING

grade. The Cold Creek ravine fill required only about 30,000 cu.yd. and when this had been placed through the culvert a temporary pile trestle was driven to carry the railroad tracks while the embankment was sluiced out and the concrete retaining walls of the under-pass were constructed. In Fig. 2 the later stage of sluicing operations is shown in which the new concrete walls and girder bridge of the railroad under-pass are in place.

Transporting the bulk of the yardage from cut No. 2 across the flat grade of the lower cut and into the big fill below was accomplished with the aid of a 50-hp., 8-in. centrifugal mud pump placed at the lower end of cut No. 2 with its intake pointed uphill toward the material to be sluiced and the discharge line laid across the Cold Creek ravine fill and through cut No. 1.

As the giant sluicing out the material worked away from the mud pump and up through the cut, the suction line was extended from time to time by adding 20-ft. lengths of pipe. This pipe was always placed so that it lay on a down grade to the pump with its intake below highway grade line. It was found that about 200 ft. of suction line was the maximum length through which the pump could draw and when this limit had been reached, that is, when the pump would no longer pick up a full load of material, the pump was moved up into the cut, lengthening the discharge line and shortening the suction line. For the last few hundred feet of the cut the material was sluiced on the 5½ per cent highway grade to the end of the suction line.

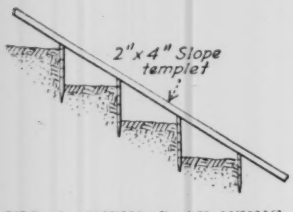


FIG. 6—METHOD OF USING TEMPLET TO INDICATE SLOPE

To avoid necessity for repriming the pump when the intake sucked in air, a bypass and a pair of gate valves were installed on the pressure line supplying the giant. With this arrangement, Fig. 4, the valve *B* was always open slightly, thus tending to prevent the formation of air pockets and in times of special need, as in starting up, or to blow out a clogged suction line, the valve *A* could be closed and *B* opened fully.

As the most effective work of the giant was done by undercutting, the slopes in the cut as left by the giant were very rough and irregular. In fact, the state highway engineers warned the contractor that these slopes could not be accepted. The contractor's plan, however, was to undercut the side slope well beyond the width of the roadbed, to the point *B* in the cross-section, Fig. 5, leaving the shaded area, *ACD*, above the slope line and calculated to be just enough to balance the area *DBE* below. Holes were then drilled in the face of the embankment to a depth of 10 or 12 ft. with a 4-in. post-hole drill and loaded with 4 to 8 sticks of 20 per cent stumping powder. These charges were just sufficient to jar the sand bank loose and the material slid into the space below on the specified 1½ to 1 slope.

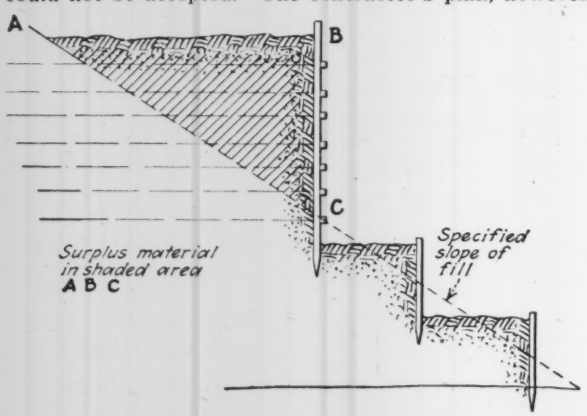


FIG. 7—RETAINING SURPLUS MATERIAL AT TOP OF SLOPE

Building up the big fill below cut No. 1 required some modification of the standard shearboard method. At the outset 2 x 4-in. stakes were used and against these were placed two 12-in. shearboards. It was found, however, that the sand came in so fast that the slope of the fill could not be properly maintained as a second row of boards would have to be started before the material back of the preceding row had been drained well enough to support any considerable weight.

The slope templet system was therefore used in which a templet was set parallel to the 1½ to 1 slope but one foot higher than the ultimate face of the fill, Fig. 6. These templets or slope guides were set at the slope stakes, 50 ft. apart. Stakes were then set in the sand, 1 ft. deep and at 4-ft. centers on a line parallel to the toe of the slope. Against these were nailed 12-in. shiplap boards, starting at the bottom and working up to a height of 5 ft., usually, with the top board touching the slope templet. As soon as the fill reached a point about 2 ft. from the bottom of the templet, another row was started 5 ft. in. Openings were left in the outer row until the berm behind had filled up to within a foot of the templet. A patch board was then nailed over these openings, thus resulting in leaving one board at the bottom of each row embedded in the sand. This board served effectively as a seal against water breaking through onto the bench below and endangering the fill.

As soon as a row was sealed, 1 x 4-in. cross pieces were set on the bench 15 ft. apart at right angles to the shearboard walls. These pieces served to prevent seepage water running lengthwise along the bench and cutting under the bottom seal board from the rear. The seepage water entrapped in this way was led down to the toe of the slope in 1 x 4-in. V-troughs.

When the fill had been about 50 per cent completed the highway engineers discovered that they had made a considerable error in judging the shrinkage. If the fill had been completed as planned there would have been some 25,000 or 30,000 cu.yd. left in the cut. This material could not have been conveniently wasted because of the value of adjacent land and if it had been piled up on top of the fill the cut width would have been narrower than was desired. The problem was solved by the contractor agreeing to build the remaining shearboard walls straight up as high as possible, tying them together across the fill with No. 4 gage wire on 2-ft. centers horizontally and 2½-ft. centers vertically.

Walls were built up in this way to heights of over 20 ft. and the material thus deposited above the slope line fell down the slope when the wires were finally cut and the walls wrecked. This method took care of the bulk of the excess material and saved considerable money over the only other alternative of piling the excess material hydraulically on top of grade to be later removed with a power shovel or other mechanical equipment. As a matter of fact the excess material that could not be deposited within the high shearboards was deposited above grade and later shoveled over the sides with a "merry-go-round" power shovel.

In the cut two men usually took care of the entire sluicing operation; one of these being constantly at the giant, of course, while it was in use. On the fill, one man controlled the fill and another controlled the settling pool while a crew of 4 to 7 men, depending on the rate at which the material was coming in, was able to keep up the erection of the shearboards. One man took care of the main pump, sharpened tools, etc. The operation was carried on for the most part for 24 hr. each day. Only the four men on each of the operating crews worked during the night shifts.

The contract for this work was held by the Johnson Contract Co. of Portland, Ore., for whom the writer was resident engineer.

International Congress Suggests Improvements in Road Practice

Conclusions Reached at Milan Sessions Epitomize European Opinion on Concrete and Asphalt

IN THE conclusions of the International Road Congress reported in the Oct. 28 issue particular attention was given to concrete road construction and to materials for bituminous roads. Largely these conclusions cite undetermined questions and advise continued study. Those which appear to be of most interest and utility to road builders in the United States are outlined here.

Bituminous Roads — Defining coarse aggregate as material retained by the ¼-in. screen; fine aggregate as material passing the ¼-in. and retained on the 200-mesh screen, and filler as material passing the 200-mesh screen, it is stressed that for wearing surface the aggregate material should be of hard, tough rock, preferably volcanic rock or limestone. Other conclusions are:

(1) The maximum size of coarse aggregate depends on the type of road, the method of execution, the nature of the traffic, and the quality of the foundation. For roads of penetration macadam and for the lower layer of double-coat roads, the limit size should be 2½ in., except in special cases. For the wearing surface of double-coat roads and for single-layer roads of mixed materials, the maximum dimension should be 1½ in. In any case the size of the material should not exceed half the thickness of the layer.

(2) The various sizes should be proportioned so as to obtain a mix of a maximum density.

(3) For fine aggregate, a correct gradation is required, the object being to give a maximum compactness to the bituminous paste. Should any given material lack any of the elements required to obtain the correct gradation desired, this must be adjusted by mixing another suitable material with it.

(4) For filler, it is advisable to use ordinary portland cement, or finely powdered hydraulic lime, or a fine powder recovered from the grinding of a suitable stone. It is advisable that the material used as filler should not leave more than 20 per cent residue on a 200 screen. It is recommended not to rely for a filler on the portion of a fine aggregate passing the 200 screen; this is rather an impurity in the fine aggregate.

(5) The penetration figure, usually determined at 77 deg. F.—though it may be sufficient to ascertain the constancy to type of a bituminous binding material, provided that the origin and method of preparation are also constant—is not sufficient to give the suitability of such a material to the requirements of a given use. It is recommended to add, to specifications for bituminous binding materials, the softening or melting point, obtained by the ball and ring method.

(6) The ductility test, carried out at the one temperature of 25 deg. C. is, in certain cases, of little significance. It is recommended to add to the specifications a low temperature test—say at zero Centigrade—and also a test at a higher temperature, when dealing with bitumens which, at a temperature of 25 deg. C. give an elongation not exceeding 50 cm.

(7) For asphaltic binding materials, it is recommended that the asphaltenes be determined by solution in naphtha, naphthalene or petroleum ether. When standardizing the methods of testing bituminous materials, it will also be necessary to define the characteristics of this solvent and specify its nature, its density and the limits of distillation.

(8) The penetration figures, suitable for the various bituminous roads, vary considerably according to the method of execution, the climate, and also the quality and intensity of traffic to which they are subjected. The degree of penetration must decrease in proportion with greater compactness in the mixture, greater fineness of aggregate, greater heat and dryness of climate, and greater intensity of traffic.

(9) In several countries good results have been obtained by preceding the surface bitumen treatment by a preliminary surface dressing with tar. This method is especially recommended for macadam surfaces composed of friable and dusty materials. Further in the experience of several countries, mixing bitumen with suitably prepared tar facilitates bituminous coating.

It appears that the addition of tar to an asphaltic binding material, when making asphalt concrete, makes it possible to apply the mixture at a lower temperature. There is, therefore, good reason for a close study of these mixtures of bituminous binders with tar and its derivates.

Concrete Roads—It is considered that concrete roads have demonstrated their suitability for heavy traffic with heavy vehicles when constructed to the standards of the best modern practice. "For roads over which pass a considerable number of vehicles with steel tires, no satisfactory system has yet been evolved."

(1) Tests of special concretes must be continued; those so far carried out, even under the ordinary conditons of traffic, have given no reliable results.

(2) The proportion of cement must in every individual case be specially determined in accordance with the thickness to be adopted for the slab and the quality of the materials available.

(3) Tests must be continued on the technical and economic suitability of metal reinforcement in concrete roads, as compared with other forms of construction intended to preserve the concrete where the foundations are not very firm or where subject to special stresses.

(4) Opinion is divided upon the advisability of transverse and longitudinal joints. When recourse is had to joints, the intervals between them are extremely variable. Observations should therefore be continued.

(5) Experiments should be pursued to ascertain the best type of jointing material to simplify the mode of preparation and the method of application.

(6) The practice of constructing roads with alternating slabs, for the purpose of reducing the dimensions of expansion joints and of diminishing cracks, deserves attention and should be further investigated.

(7) The coating of concrete roads with bituminous mixtures may, in many cases, be productive of notable advantages, and should be further investigated.

(8) Tests in connection with the silicatization of the surfaces of concrete roads with a view to their being made harder and to aid preservation must be continued.

(9) The use of mechanical processes for the construction of concrete roads is advisable from the technical point of view, whenever economic difficulties or special working conditions are not encountered.

(10) For repairing damaged parts, the use of mechanical appliances is to be favored, quick hardening cements or asphalt concretes being employed.

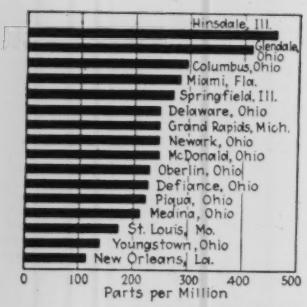
New Water Softening Plant for Hinsdale, Illinois

Lime and Soda Ash, Carbonation to Prevent Pipe Incrustation and Filtration of Very Hard Water

By Frank D. Danielson
Village Manager, Hinsdale, Ill.

After several months of investigations, Hinsdale, Ill., recently placed in operation a new and complete water softening plant, including a carbonizer. Its old softening plant, which had been in operation ten years, was abandoned for reasons given later in this article.

Hinsdale is a suburb of Chicago having a population of nearly 7,500. Its water supply is derived from wells reaching down into the Niagara limestone. This water contains approximately 35 grains per gallon of dissolved solids of which about 30 grains are calcium and magnesium salts. For 25 years this hard mineral water was pumped directly into the distribution system. In 1915 a 0.96-m.g.d. water softening plant was installed at a cost of $25,000. The sequence was: application of lime and soda-ash, agitation, sedimentation and filtration.

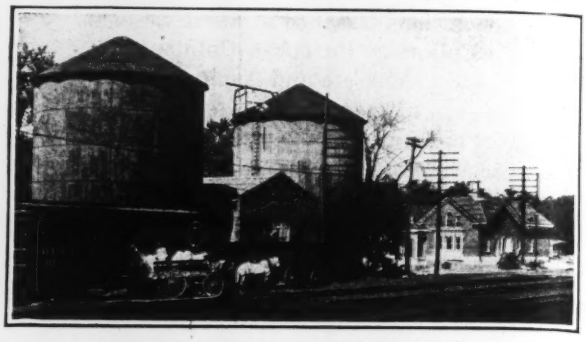


COMPARATIVE HARDNESS OF RAW WATER AT 16 SOFTENING PLANTS

From figures collected by C. P. Hoover.

In softening water, excesses of chemical must be fed to insure the reduction of the calcium and magnesium compounds. The amount of this excess is shown in the causticity of the water ready for pumping into the distribution system. Although the elapsed time between the introduction of the chemical and pumping the water into the mains would be acceptable for water to be used industrially, it is inadequate for municipal supplies. With a greatly lengthened time element the causticity would be less, but reducing it to the lowest practicable limit, by time alone, it is impossible to eliminate all of the causticity. Further treatment must be applied for the entire elimination of the caustic condition. This excess of chemical, even after long reaction time, and particularly upon any increase in temperature of the water, will continue as long as any excess chemical is left, forming a precipitate in all pipe lines and water services. The most serious after precipitation occurs in the heaters used for providing domestic hot water supply.

These facts were overlooked in most of the municipal water softening plants placed in operation up to 1921. The water softener constructed by Hinsdale in 1915 was no exception. Tons of deposit were forced into the distribution system every year, some of which could not be removed. The incrustation from this deposit became absolutely hard with time and gradually reduced the size of the mains. To prevent any further precipitate in the underground mains, the service lines, and in the hot water system of piping in the houses, this caustic quality of the treated water had to be eliminated. By using CO_2 in the new plant the normal carbonate alkalinity and the caustic alkalinity are converted to bicarbonate alkalinity in solution and after precipitation is prevented. The accompanying sketch gives data regarding some of the plants inspected before designing the new plant. How the raw water at Hinsdale exceeds in hardness that of 15 other cities having softening plants is shown by the accompanying diagram.

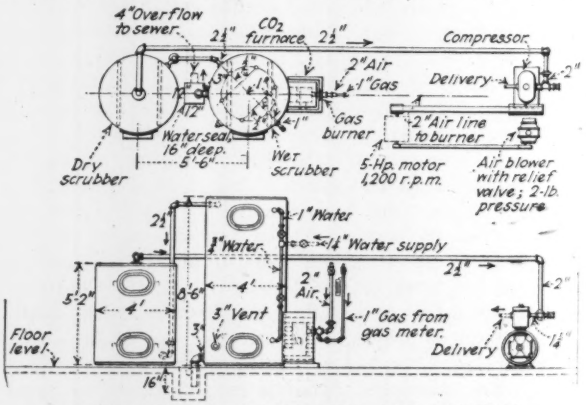


OLD AND NEW WATER SOFTENING PLANTS FOR VILLAGE OF HINSDALE, ILL.

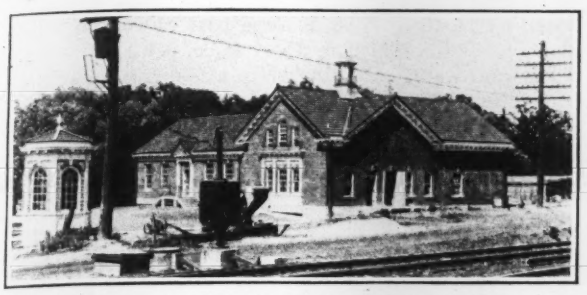
Shows change in both industrial art and esthetic sense, 1915 to 1925. Left to right: Old 0.25 m.g.-softening tank, with chemical house and 0.25-m.g. storage tank for treated water; deep-well pump-house; new softening plant combined with main pumping station.

Hinsdale's new plant was put under construction in August, 1924, and placed in operation Sept. 8, 1925. It has a normal capacity for softening and carbonizing 2.3 m.g.d. and a maximum capacity of 3 m.g.d. The essential new features of the present plant over that of the old are: (1) Utilizes the split method of treatment. (2) Mechanical agitation in mixing tanks. (3) Equipped with a clarifier for the continuous removal of precipitated sludge. (4) Return of sludge to mixing tanks. (5) Chemicals applied dry by automatic control. (6) Co_2 applied to treated water. (7) Constructed on a unit plan basis so that the present equipment would ultimately be part of a much larger softening plant. (8) Plant sectionalized so that half can be operated apart from the rest. (9) A sub-basement and a pipe tunnel 500 ft. long make all piping and equipment accessible. (10) Houses the motor-driven service pumps.

The raw or untreated water may be pumped to the mixing tanks from an old 12-in. well or from a new 19-in. well equipped with a deep-well centrifugal pump. The raw water enters two chemical mixing tanks at the bottom through an 18-in. pipe to lessen the motion. Hydrated lime and soda ash are fed into these mixing tanks by dry feed apparatus equipped with automatic



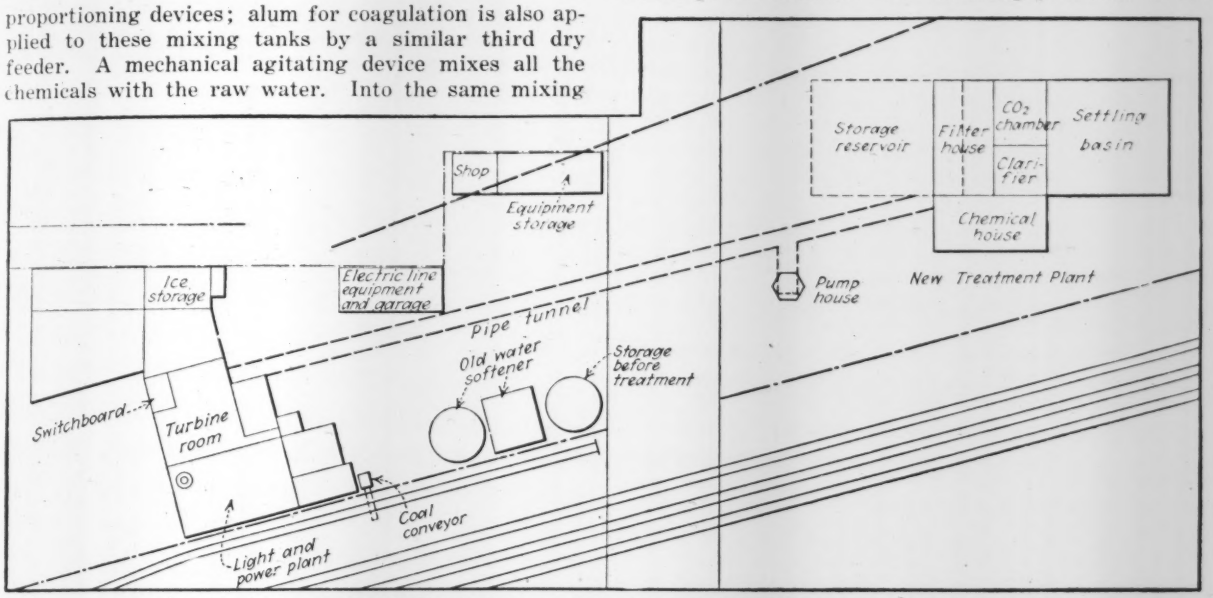
CARBON DIOXIDE GENERATOR FOR HINSDALE WATER SOFTENING PLANT



NEW WATER SOFTENING PLANT AT HINSDALE, ILL.
The small building at the left houses the new deep-well pump.

proportioning devices; alum for coagulation is also applied to these mixing tanks by a similar third dry feeder. A mechanical agitating device mixes all the chemicals with the raw water. Into the same mixing tanks is applied the precipitated sludge pumped from the clarifier. The velocity of mixing in each tank is 1.2 ft. per second. Each tank is 12 ft. in diameter and 19 ft. high, giving a holding capacity of 16,500 gal., with a total retention period of 20 minutes. This period and velocity of mixing were shown by laboratory experiments by C. P. Hoover, consulting chemist, Columbus, Ohio, to be adequate for the necessary chemical reaction and floc formation.

From the mixing tanks the treated water enters a long trough and is passed to a concrete clarifying basin, 28 ft. square and 16 ft. deep, with a capacity of 0.1 m.g. The basin, equipped with a Dorr clarifier, adjoins the sedimentation basin. It can be used or bypassed. Continuous removal of sludge is provided through a 6-in. pipe drain in the bottom. The retention period in terms of normal plant capacity is one hour. Approximately 75 per cent of the precipitated sludge is removed by means of the clarifier. All the sludge removed is returned to the mixing tank and applied with the chemicals. After operation of the plant has stopped each day, the sludge is blown down by draining to the sewer for a period of about two minutes. No sludge is wasted during operation.



LAYOUT OF NEW WATER SOFTENING PLANT FOR HINSDALE IN RELATION TO OLD PLANT
Water, light and ice plants are operated jointly by the village. Combined light and ice plants shown at left. Water pumping plant formerly combined with the other station. At new plant, spray pond for light plant is located over settling basin.

COMPARATIVE DATA FOR FIVE MUNICIPAL WATER SOFTENING PLANTS

	Size M. G.	Chemicals Used	Division of Chemicals	Alum Applied	CO_2	Velocity of Mixing	Agitation	Time Element in Mixing Chamber	Time in Sedimentation Basin Hr.	Caustic Alkalinity	Total Hardness Treated Water p.p.m.
Grand Rapids, Mich.	15	Lime and alum	30 min. double charge of lime only; then 30 min. without lime; alum continuous	Just before lime treatment	Not used but favorable for use	1 ft. per sec.	Baffles only	30 min.	3 to 4	3 to 5 p.p.m.	100
Defiance, Ohio	3	Lime and alum; soda ash during winter	No division	15 min. after lime and soda-ash treatment	Used coke furnace generates gas		Baffles only	45 min.	8	Zero because of CO_2.	115 to 120
Newark, Ohio	6	Lime, soda ash and alum	½ of water treated for 10 min.	At same time with lime and soda ash	Used flue gas process abandoned, now burning coke	1 ft. per sec.	By baffles and mechanical means	2 hours	8	Zero using CO_2	80
Delaware, Ohio	2	Lime, soda ash and alum	No division	At same time with lime and soda ash	Used coke or oil furnace generates gas	Did not depend on baffles	Mechanical	1 hr. and 20 min.	6	Zero using CO_2	98-100
Columbus, Ohio	30	Lime, soda ash and alum	25 per cent of water treated with all chemicals at one time	At same time with lime and soda ash	Would like to use CO_2 watching performance at Newark and other places	0.6 ft. per sec.	Mechanical and by baffles	1 hr.	8	About zero without CO_2 (under-treating)	About 100

From the clarifier the water passes to a 0.75-m.g. settling basin with a retention period of nearly 8 hr. at normal plant capacity or 20 hr. at present consumption.

After settlement the water passes over a weir into the CO_2 basin which is 13.5x30 ft. in plan and 18 ft. deep. The CO_2 gas is supplied to the water through a pipe diffuser system having $\frac{3}{32}$-in. outlets 1 ft. apart each way located 17.5 ft. below the surface of the water.

Illuminating gas as locally furnished by the gas company is burned to produce CO_2 required in the new softening plant at Hinsdale. This method is simplest, cleanest, and most certain of all, and requires no special apparatus being as simple as the operation of an ordinary gas stove. A gas main enters the chemical house and ends in a meter, from which the supply pipe to the furnace is run. The furnace is constructed to burn either gas or oil. To treat 1 m.g. of water requires 550 lb. of CO_2, which in turn requires 7,500 cu.ft. of Hinsdale gas. An oil manometer on the gas feed pipe indicates when all gas used is burned; an excess of this will be unburned and therefore wasted. Under all conditions the air valve at the burner may be kept wide open; all of the regulating for the capacity of CO_2 is made with the gas valve. The gas plant as installed is capable of delivering from 15 to 40 lb. of CO_2 per hour.

Frequent analysis of the filter sand indicates that the Co_2 is doing its work. After fourteen months of operation no incrustation on the grains of sand due to the lime treatment is found. The old treating plant would have required almost a continuous removal during this period of time due to growth of sand particles.

After carbonation the water passes through the filters to a 0.5-m.g. storage reservoir.

Four tests, known as total alkalinity, phenol alkalinity, hardness and free CO_2, are made on the softened water every two hours of plant operation. If twice the alkalinity to phenol is more than the total alkalinity, caustic alkalinity is present, that is, too much hydrated lime. The total hardness should just about equal the total alkalinity, if it is less than the total alkalinity, the soda ash must be cut. If it is more than total alkalinity, the soda ash must be increased. The water from the carbonator should show no free CO_2. If it does, the supply of illuminating gas must be cut down. If the water leaving the carbonator shows red color when phenol is added to it, not enough CO_2 has been added.

Daily average analytical results, parts per million, are:

	Raw Water	Effluent Dorr Clarifier	Carbonated Water	Filtered Water
Total alkalinity.....	375	110 to 140	About the same	About the same
Phenol alkalinity....	0	60 to 80	10-15	About the same
Caustic alkalinity...	0	0 to 30	0	0
Total hardness.....	472	90 to 120	100-130	About the same

To treat 1,000 gal. of raw water requires 2.8 lb. of hydrated lime, $\frac{3}{8}$ lb. of 58 per cent soda ash, and about $\frac{1}{8}$ lb. of alum. In other words, approximately 1,700 lb. of hydrated lime, 400 lb. of soda ash, and 75 lb. of alum are required per 24 hours for an off-peak requirement of 600,000 gallons.

The results after operating our water softening plant fourteen months have fulfilled all expectation in regard to softness, ending incrustation, and operating cost.

Meters, mains and house plumbing have already shown the value of using CO_2 gas. The filter sand is as clean and sharp today as it was when the plant was started.

One operator is able to take care of the entire softening plant, and also give the required attention to the electrically-driven pumps which supply the city distributing system. The average cost of softening and carbonizing the Hinsdale water is 6c. per 1,000 gallons.

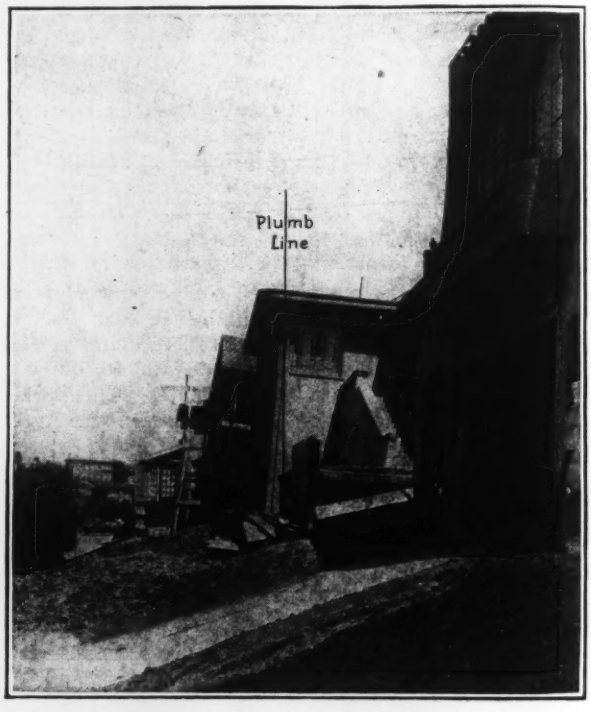
The new water softening plant was financed partly by bonds ($65,000) and partly by operating revenue from the municipally-owned water, light and ice plants. The work was done with the village's own equipment and construction organization for a little over $102,000. The writer directed the design and construction.

Residences Wrecked by Slide at Oakland, Calif.

Movement Caused by Water-Bearing Seam Overlying Slippage Plane—Drainage by Ditches and Tunnel Effect Remedy

BY CHESTER R. HUNT
City Planning Engineer, Oakland City Planning Commission

AN earth slide occurred early this year in the residential district of Oakland, Calif., which entirely ruined half a dozen buildings, moved others several feet from their original location, ruptured utility connections and made impassable pavement and sidewalks on Lerida Ave. The size of the moving area was roughly, 250 x 500 ft. Damage to the streets made it legal for the city to undertake the remedial work and after some exploration a system of surface and subsurface drains was put in chiefly on private property to drain and to keep water out of the slippage plane which is believed to be primarily responsible for the slide.



HOUSES ON LERIDA AVENUE BADLY OUT OF PLUMB
A settlement and slide combined tilted the houses at the same time they were moved downhill.

When the serious nature and extent of the slide was appreciated the city appropriated $1,500 for a preliminary investigation and appointed a committee consisting of the city engineer, the assistant city engineer and the writer, with the latter in active charge, to advise

ON THE UPPER CLEAVAGE LINE
Parted fence rail shows the amount of settlement. Note emergency rubber sewer connections.

on remedial measures. Investigation showed that some 25 years ago there was a large spring in the sliding area and, in fact, that the entire area affected was then known as "Slippery Hill." More or less regrading had been done when this property was subdivided and for a time there had been no serious disturbance.

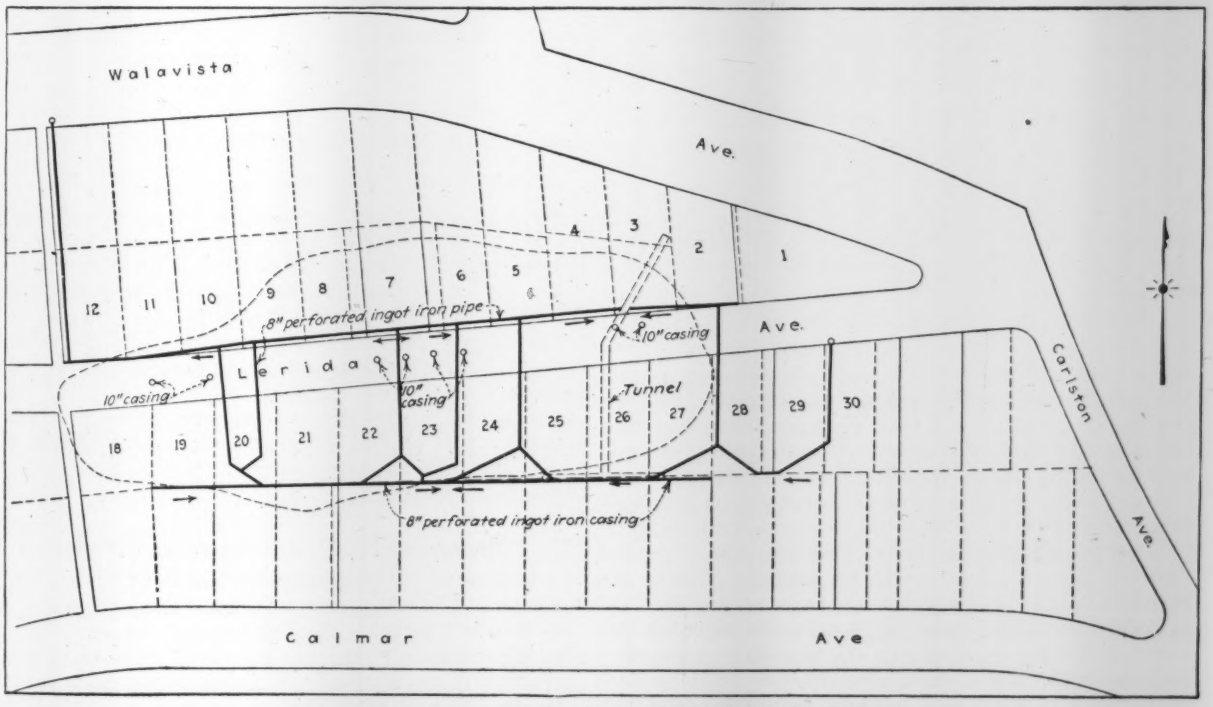
More recently, however, it seemed probable that something had occurred to change some subterranean water course or open up a fault line so that surface water had saturated a sliding plane some distance below the surface. It was observed that at the lower edge of the slide material was rising and flowing outward. In fact, a distinct wave was observed along the lower edge of the slide with its lower edge curved under by the characteristic rising and flowing motion.

Two rotary drill rigs were used to make borings along Lerida Ave. Samples taken every 2 ft. from holes driven about 40 ft. deep into the Franciscan clay which forms the core of the hill showed that the slide was occurring at depths varying from 18 to 20 ft. The line of cleavage was apparently along a stratum of serpentinized clay varying from $\frac{1}{2}$ to 2 ft. in thickness which in turn was overlain by a stratum of limestone gravel and clay. The latter stratum was water-bearing and varied in thickness from 10 in. to 3 ft. Upon this was a layer of yellow clay (coarse kaolin) of varying depth, and at the top a layer of black soil, 2 ft. or more thick.

For two or three years past different property owners in the district have observed settlement in their houses. In one instance the whole foundation under a large residence had to be replaced. These incidents indicated that the extensive slide early this year was a natural development of conditions that had been progressing for some time.

Another incident that helped to fix the relation between earth movement and water in the slippage plane was that slippage was always worse after rains until the rainwater had time to drain out of the ground. In one case where a local movement continued longer than usual after a rain, it was found that a sewer line had broken and the flow was escaping into the ground. When this break was repaired the local movement immediately stopped.

The problem was to find the most effective and economical means of draining the affected area and keeping out of it the water that was causing the trouble. Because of the large number of property owners involved it was not considered feasible to get rights-of-way for a deep ditch that would roughly follow the lines of cleavage at the upper end of the slide. The plan decided upon was a system of surface drains to catch infiltering water near the surface and also a tunnel which would tap subterranean sources in the vicinity of the old spring.



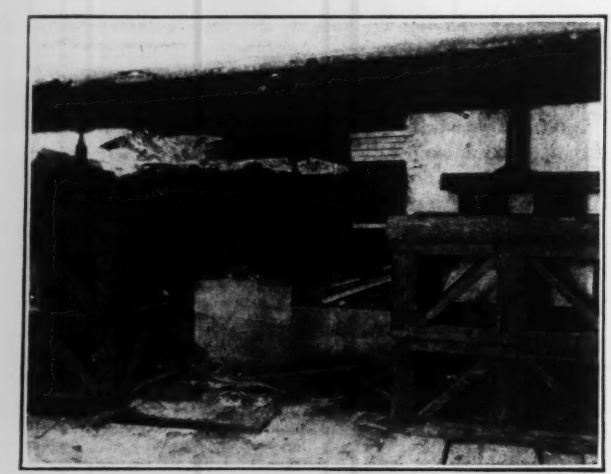
SLIDING AREA; LOCATION OF DITCHES AND TUNNELS

While the preliminary investigation was under way, daily surveys based on reference points beyond the area of the slide showed the maximum movement to be centered at two points, namely, lots 25 and 26 and lots 20 and 21. During this time a system of surface ditches was dug with pick and shovel roughly along the location of the permanent ditch system shown on the drawing.

About the time that this preliminary ditch system was completed a torrential rain occurred, several inches falling in 24 hr. For three weeks previously the earth movement had steadily decreased but immediately after the rain the movement started again at a highly accelerated rate so that the house on lot 7 moved 15 in. in one day, about three times the maximum rate previously recorded. The preliminary ditch system proved highly effective, large quantities of water being carried while the rain continued and after the rain stopped it was observed that the earth movement decreased much more speedily than before the ditches were put in.

The permanent drainage system shown on the accompanying map was designed to afford a double cutoff wall between the ridge and the slipping area, thus diverting all drainage water, both surface and subterranean, either into the tunnel or to a street outlet on Walavista Ave. Because of the unstable condition of the ground it was not considered advisable to use ordinary drain tile in the ditches; some means of collecting the water was needed which would not be disrupted by subsequent movements.

Corrugated iron culvert pipe, perforated in the upper

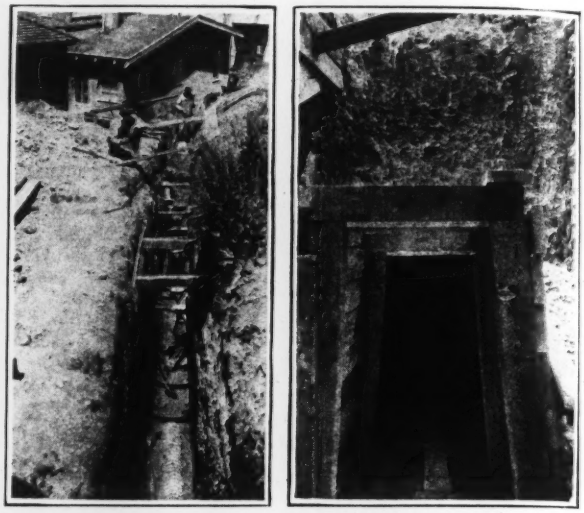


JACKS AND TRESTLES TO KEEP HOUSES PLUMB
By this method some of the houses were leveled up from time to time while settlement as much as 6 ft. was occurring.

half, was therefore used and connections between lengths were made by means of corrugated coupling bands. The total area of the perforations was made such that in any one length of pipe it exceeds the cross-sectional area of the pipe itself. About 7,000 ft. of this pipe, 8 in. in diameter was used and placed in ditches dug down to a level below the water-bearing material.

Backfill was of an impervious clay, well tamped, carried up to the level of the perforations. Above this crushed stone backfill was used, the size varying from ½ to 6 in. and the thickness of the stone layer varying from 2 to 6 ft., depending on the material traversed.

There was difficulty in contracting the tunnel work in that the city could legally enter into a contract only



SURFACE DRAINAGE DITCH AND PORTAL OF TUNNEL
For the drainage ditch line, corrugated pipe perforated in the upper part was used instead of drain tile, because of danger of further slippage. The main drainage tunnel was continued about 345 ft. into the hill and developed at water flow of ½ sec.-ft.

after the exact location of the tunnel had been delineated precisely on a map. A location was therefore selected which it was hoped would secure the maximum draining effect and since no deviations from the lines shown on the map would be legal the tunnel was left open, in view of the possibility that additional contracts for tunnel work would be necessary. The tunnel was made of the minimum cross-section that could be conveniently worked (about 4 ft. wide by 7 ft. high) and was timbered and lagged. When the tunnel had been driven a total distance of 345 ft. as shown on the map, it was developing about ½ sec.-ft. of water most of which came from a sand seam about 4 ft. thick and 30 ft. wide. This flow was continuing in August, which, in the present dry year, indicates that probably one of the chief sources of trouble has been remedied. If and when the tunnel is decided to be a necessary and permanent part of the improvement, the plan is to place in it a perforated pipe and then backfill with crushed rock.

The greatest obstacle to the speedy and successful carrying out of this work was the legal restrictions which attend municipal work of this sort. No work could be done on land from which easements were not obtained and some of these easements proved to be quite difficult to get, notably in the case of land not in immediate danger. These easements were prepared in the office of the city engineer and a committee of residents obtained the necessary signatures and returned them to the office.

The results already obtained are believed to verify the analysis of the causes and the writer is confident that the present work will constitute a permanent and effective remedy.

Photographs of Cuba Hurricane Damage

In *Engineering News-Record* last week, in the article on pp. 753 to 755 on the hurricane in Cuba on Oct. 20, there was a group of four photographs showing damage to structures in Cuba. For the use of these photographs credit is due to the paper, *El Mundo*, of Havana, through the courtesy of which the views were used.

Some Lessons Learned in Building Long Concrete Bridge

Pile Foundations—Proportioning and Handling Concrete—Slump Tests—Erecting Steel Ribs for 264-Ft. Span—Arch Deflection Tests

By John F. Greene
Resident Engineer, Toltz, King & Day, Inc., Engineers and Architects, St. Paul, Minn.

CONSTRUCTION work on the new Robert St. concrete arch bridge over the Mississippi River at St. Paul, Minn., presented a number of special features. The design of this bridge was described in *Engineering News-Record* of Oct. 21, p. 732. Among the construction features involved were: The removal of a 5-ft. stone sewer; the diversion of the sewage to clear the foundations of the bridge, and the construction of a new reinforced-concrete sewer; the removal of the old steel bridge, containing approximately 2,200 tons of steel; the removal of the old stone piers, including the pile foundations; the construction of cofferdams for seven pier foundations; the driving of 3,700 permanent wood piles from 40 to 54 ft. in length; the driving of 800 cast-in-place concrete piles; and the placing of 50,000 cu.yd. of concrete, 1,100 tons of reinforcing steel and 1,000 tons of structural steel. Two of the five-rib 112-ft. arch spans are shown in Fig. 1, while Fig. 2 shows one of the structural steel ribs for the 244-ft. arch.

Removal of Old Bridge Piers—Because three of the piers of the new bridge were so located as to conflict with piers of the old bridge, it was necessary to remove the latter completely. This condition involved enlarging the cofferdams to enclose both the old and the new foundations; the removal by blasting of the masonry of the old piers; the removal of a pad consisting of three layers of 8-in. timbers resting on piles spaced 36 in. c. to c., and the pulling of the piles. These piles, entered on the construction records of the old bridge as from 24 to 30 ft. long, actually ran from 7 to 20 ft. in length, with an average of less than 15 ft. The 8-in. timbers, placed in 1885, were in good condition and were used for arch falsework.

The cofferdams for the piers, approximately 100 x 50 ft., were constructed of 35-ft. steel sheetpiling driven through sand with a double-acting steam hammer to a penetration of not less than 12 ft. below the bottom of the finished excavation. This piledriving was carried out in accordance with a well conceived plan which gave excellent results. All the sheetpiles were set in place and driven only a few feet before making the closure. They were then driven in stages of approximately 5 ft., the hammer swinging in light leads from a derrick boom. The piles were carefully plumbed at regular intervals. Obstructions encountered in driving, which included piles and timbers of the cofferdams for the piers of the old bridge, were removed after pumps had been installed and the water lowered. Before the installation of the pumps, the excavation was carried on with a 1-yd. clamshell bucket. The bracing for the cofferdams was framed and packed in tiers at the water surface and was allowed to settle as the water was pumped out. It consisted of 10-ft. bays with four tiers of 12 x 12-in. timbers.

Piledriving—Piles for piers 3 and 4, at the ends of the main span, were 54 ft. long; those for the remaining piers were 40 ft. long. They were of Norway pine, fresh cut, and inspected in the woods of northern Minnesota at the time of cutting. Driving the 54-ft. piles through sand was a difficult operation which involved considerable skill in the use of a high-pressure jet in order to secure the alignment of piles 30 in. c. to c., without interference. They were driven with a steam hammer having a 5,000-lb. ram and a stroke of 36 in. In those piers in which the piles were not driven to rock, a penetration of 1 in. in ten blows was adopted as a stopping goal, giving a bearing of 150,000 lb. per pile according to the *Engineering News* formula.

The pine piles were peculiarly suitable for such driving because of their shape. A Norway pine grows with a very slight taper from tip to butt; many of the piles 54 ft. long were 10 in. at the tip and only 14 in. at the butt. Cypress and cedar piles with a heavy swell from tip to butt were driven to a full stop at 25 ft., even with the jet. After trying to drive such piles in the first pier, the results were so unsatisfactory as to warrant the exclusive use of Norway piles.

Approximately 800 concrete cast-in-place piles were used in the foundations for eight concrete bents and for a high concrete retaining wall on the east side of the south approach. While the plans called for 30-ft. piles, the average penetration did not exceed 24 ft. The type of pile used, having a heavy taper like that of a cedar pile, appeared to bring up very quickly when driven in sand. A steam hammer was used for driving the steel core; frequently it was necessary to drive the steel core more than 3 ft. at a penetration of 1 in. in ten blows in order to get a 20-ft. pile. A core with a larger tip and a smaller butt would have been more satisfactory.

Construction Plant—The main concrete plant, containing a 1-yd. mixer, was located on the south bank of the river, under the deck of the old steel bridge. Sand and gravel were delivered in bottom-dump cars over a trestle which passed under the south arch. These materials were dumped into the boot of an elevator which raised and dumped it on a belt conveyor for delivery to the bins. Cement was hauled in over the deck of the old bridge in trucks, and was dumped into a chute which ran through the material bins to the measuring hopper.

Concrete was conveyed from the mixer in four-car trains of 1-yd. side-dump cars drawn by a gasoline locomotive over a timber trestle east of and parallel to the center line of the bridge. A "marine tower" with a hoist on a deck 15 ft. above the track, ran along this trestle. The concrete for the superstructure was dumped into a hopper at the foot of the tower and elevated to the level of the deck, thence to be conveyed to place by buggies. Concrete for the pier substructures was dumped into a 2-yd. bottom-dump bucket handled by a derrick. Concrete for columns and pier walls was placed through chutes composed of 8-in. pipes in 3-ft. lengths fastened together by chains.

Concrete Proportions—The specifications called for six bags of cement per yard of concrete; crushed trap rock for the substructure; crushed limestone for the superstructure; 1½ minutes per batch in the mixer, and a tentative 1:2:4 mix. Preliminary tests were made to determine the effect of over-sanding. It was found that over-sanding to the extent of 1 of cement to 2.6 of sand to 3.4 of crushed rock resulted in an average compressive strength at 28 days of 3,800 lb. per square inch. Hence, over-sanding was permitted when necessary. For consistency, a slump of 2 in. was specified for mass work and 3 in. for the remainder.

It was the intent of both the engineers and the contractor to obtain the strongest possible concrete for the illustration. Run a 7-in. slab on a grade of 3 per cent with a 2-in. slump and a water content of less than 4.5 gal. of water per sack, measured at the mixer. The resulting concrete, after straight-edging and working, will be soupy.

It is the judgment of the writer that samples for testing should be taken only in the hole and from the wettest concrete in the hole, not from the mixer or from buggies. This is the only way to allow for the results of an accumulation of a slight excess of water from each batch or the accumulation from an occasional sloppy batch which has passed the mixer man and which the inspector has hesitated to waste.

Any specification which allows the contractor to use

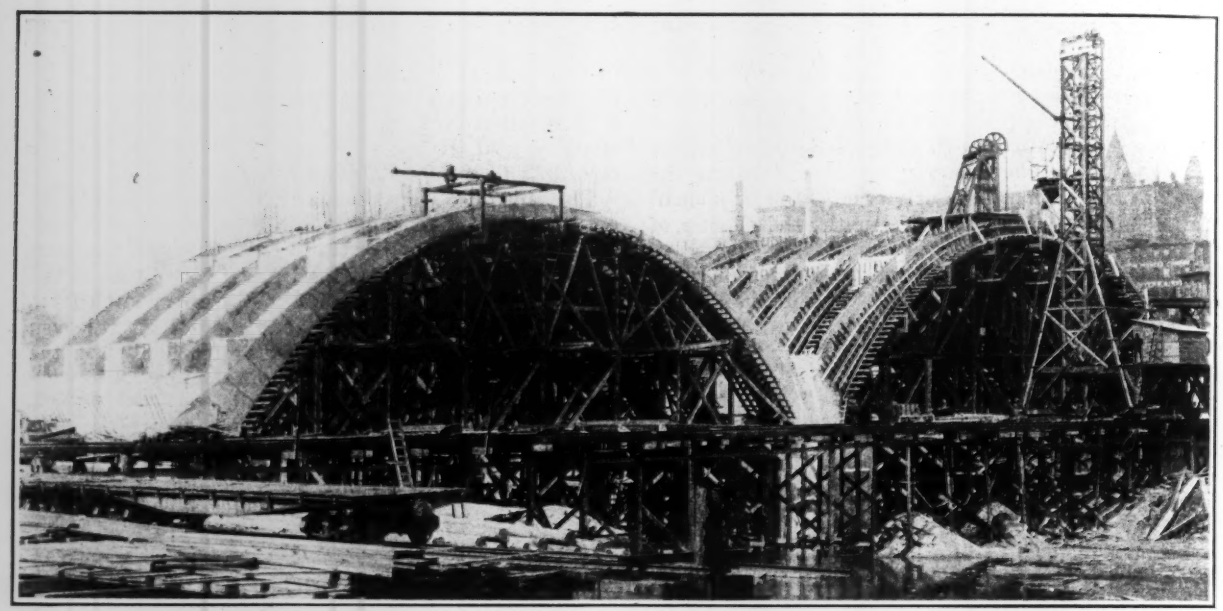


FIG. 1—TWO FIVE-RIB ARCHES: 112 FT. CLEAR SPAN
Traveling concreting tower on trestle at right.

specified cement content, regardless of the specified slump. The unwritten law which prevailed on the job from the beginning was: "Make the concrete as dry as you can, consistent with workability." The average slump for 30,000 yd. of concrete placed in the substructure did not exceed ½ in. The average compressive strength at 28 days, for cylinders taken daily, exceeded 3,700 lb. and many of the cylinders broke at more than 5,000 lb. per square inch.

Work of this class calls for a conscientious effort on the part of the contracting organization and the most careful supervision on the part of the inspection staff, but the results are worthy of the effort and speak for themselves. The work has been done so well that pier after pier stands, after the removal of forms, without patches or rock pockets.

Water Content of Concrete—It may be appropriate to consider a phenomenon with which many construction men are familiar. Assume a column or a wall, large enough for a man to work in. Place concrete in this wall of a consistency to give a 1-in. slump at the mixer or as sampled out of a buggy. Run 7 ft. in depth of this concrete in three hours with men spreading the concrete. At the end of the run there will be loose water on the top of the concrete and the material tested in the hole may show a slump of 4 in. Take another

an excessive amount of water, provided that the water ratio as measured at the mixer remains constant, is overlooking this constant accumulation of the excess from each batch, which may result at the end of the day's run in a soupy segregated stratified mass with few of the qualities of the materials as tested at the mixer. To put it into job phraseology: the concrete should be bought "f.o.b. the hole," not at the mixer, the dumping hopper or in the buggy.

Proper concrete inspection involves complete supervision of every yard of concrete placed, by a man trained to know when the consistency is right for the proper compacting of the concrete, who will see that the concrete is properly worked to form a dense mass, and is spaded to give smooth surfaces free from rock pockets. This man, with the job slogan in mind, "dry it up whenever you can," may vary the consistency many times in a day. When running the main arch ribs, enclosing heavy structural steel members, consistencies were varied frequently. And since the inspector in the hole is naturally inclined to take a little more water than he needs, in order to reduce the labor of spading, it is incumbent upon the inspector at the mixer to keep the men in the hole asking for more water. There should be a constant pressure at all times to keep the consistency close to the limit of workability,

if the aim is to get the greatest value for money expended.

Through-Arch Main Span—The structural steel ribs provided in the through arch of 244-ft. clear span to transfer the floor load from the 90-in. steel floorbeams to the concrete ribs, were fabricated with the ends of the chord members milled to give full bearing at each joint. When the steel had been erected, it was found that many of the joints did not have full bearing, the openings varying from 1/100 to ⅛ in. It was decided to full rivet all joints, holes being drilled in the field, and plates and rivets added to develop the chord sections. One of these ribs is shown in place in Fig. 2.

The forms for the concrete ribs were suspended from the structural steel. Each rib was divided into ten sections and three keys, one key at the crown and one near each third point. This is shown by the drawings in the previous article already noted. It was required that an interval long enough to develop 1,000 lb. per

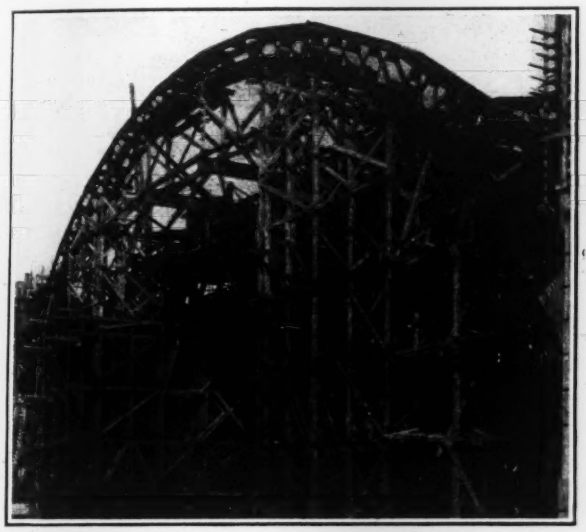


FIG. 2—STEEL RIB ERECTED FOR 264-FT. CONCRETE ARCH

sq.in. in compression should elapse between successive days of concreting, in order to lessen the probability of destroying the bond between the concrete and the structural steel. The average compressive strength of the cylinders at four days was 1,560 lb. and the maximum at five days was 2,216 lb. The keys were concreted six days after the last section had been poured.

Arch Deflections—An excellent opportunity offered to measure vertical movements of the main arch resulting from: (1) Rib shortening under load, (2) rib shortening due to setting of the concrete, and (3) changes due to rise and fall of temperature. The first reading was taken upon the completion of the riveting of the structural steel March 8, with the temperature of the air at 14 deg. F., and thereafter at intervals of a week until the final reading July 10.

Computations for deflection were based upon the following formulas:

$$\Delta h = \frac{h}{l}\Delta l + i_h \Delta l$$

$\frac{h}{l}\Delta l$ = Deflection due to rib shortening from temperature.

$i_h \Delta l$ = Deflection due to temperature moments.

i_h = Influence ordinate for crown thrust for a unit load at the crown.

h = rise at intrados.

b = clear span.

On May 18, just after the keys had been concreted, when the steel ribs were carrying the full load, with no deflection due to the setting of the concrete, the following conditions prevailed:

Temperature change from 14 deg. to 66 deg.	+52
Computed rise due to temperature	+0.091
Computed deflection due to load	—0.033
Computed net rise	+0.058
Measured rise; average of two ribs	+0.061

On July 10, upon completion, and two months after the keys had been concreted, conditions were as follows:

Temperature change from 14 deg. to 70 deg.	+56 deg.
Computed rise due to temperature	+0.098
Computed deflection due to load	—0.047
Computed net rise	+0.051
Measured rise	+0.023
Net settlement during two months	—0.028

Computed deflections were based upon an assumed modulus of elasticity of 4,000,000 for the concrete. This assumption was based upon curves shown on page 39, Bulletin No. 5 of the Lewis Institute, for concrete with a compressive strength of 4,000 lb. It is interesting to compare these measured deflections with those found by Considère and Freyssinet for long-span concrete ribs constructed with semi-hinges. Assuming a compressive stress of 350 lb. per square inch:

			Per Cent
(1)	Shortening due to load—per unit of length	0.00009	13.6
(2)	Shortening due to 40 deg. drop in temp.	0.00028	42.5
(3)	Shortening due to setting of concrete at three months (Considère)	0.00029	43.9
	Totals	0.00066	100.0

The shortening due to the setting of the concrete at 60 days, on the Robert St. bridge, concreted in the manner already described, and with a structural steel frame carrying the load during the setting of the concrete, was 0.00009, approximately one-third that found by Considère for concrete ribs constructed with falsework centering in the ordinary manner. The unit shortening to compare with Considère's finding, assuming the compressive stress at 350 lb., was as follows:

			Per Cent
(1)	Shortening due to load	0.00009	19.6
(2)	Shortening due to 40 deg. drop in temp.	0.00028	60.8
(3)	Shortening due to setting at 60 days	0.00009	19.6
	Totals	0.00046	100.0

Assuming the modulus of elasticity at 2,500,000, the tabulation would be as follows:

		Robert St. Bridge		— Considère —	
			Per Cent		Per Cent
(1)	Shortening: load	0.00014	27.4	0.00014	19.7
(2)	Shortening: 40 deg.	0.00028	55.0	0.00028	39.4
(3)	Setting	0.00009	17.6	0.00029	40.9
	Totals	0.00051	100.0	0.00071	100.0

Apparently the structural steel frame and the method employed in concreting the arch ribs contributed to a marked reduction in the amount of the settlement of the arch after the completion of concreting.

Concrete Railing—The parapet or hand rail was constructed by the dry process to give the surface a texture free from air and water holes. Blocks approximately 24 in. square and 7 in. thick, of a somewhat intricate

design, were prepared in aluminum molds. With two sets of molds, a crew made forty blocks in nine hours.

This railing was constructed as follows: Forms for a somewhat massive post were erected containing two galvanized inserts to receive the railing on both sides. In concreting a post, a light steel form, 12 in. deep and 4 in. smaller than the post, was placed inside of the outer wooden forms, a shell of dry mixed concrete was pounded in, the core was filled with ordinary wet concrete and the steel form was raised a foot. One man would complete six posts in a day.

In the next operation, the running of the base, the men chose to complete the section with the dry mix, scoop out the core and refill with normal wet concrete. The intermediate precast panels were set by stone masons with ½-in. joints, grouted and pointed. The top section of the rail was prepared in the same manner as the base. At both ends of each bay a ½-in. strip of elastite was inserted between the post and the panel to allow for expansion.

The success of the dry-process method of making an ornamental rail involves the application of water to the finished rail many times each day for a period of two weeks. While compressive tests of the dry concrete at 28 days showed only 1,300 lb. per sq.in. tests were made to ascertain whether cleavage planes would result between the dry and the wet portions. Sections of the rail were removed and it was found that there were no cleavage planes and that the combination was a structural unit. The completed handrail, just as it emerged from the forms, with no patching, rubbing or grinding, is of a texture which compares very favorably with sandstone. Models for the twelve medallions which crown the outer faces of the piers were prepared by the Brioschi-Minuti Co., St. Paul.

Plans and specifications for the Robert St. bridge were prepared by Toltz, King & Day, Inc., St. Paul, Minn., who also supervised the construction: Max Toltz, mechanical engineer; W. E. King, structural engineer; B. W. Day, architect; Roy Childs Jones, architectural design; P. E. Stevens, office engineer; W. A. Thomas, electrical engineer; and John F. Greene in charge of arch design and resident engineer. The bridge was built by the Fegles Construction Co., Ltd., Minneapolis, Minn., with James Patterson as superintendent and Charles Moore as assistant superintendent.

Reinforcing a Steel Viaduct: Northern Pacific Ry.

Towers Strengthened by Additional Steel on Columns and Bracing—New Girder Spans—Precast Concrete Slabs for Ballasted Track—Methods of Handling Work Under Traffic

TO PROVIDE for the heavier locomotives and higher speeds of trains now operated on the main line of the Northern Pacific Ry., extensive reinforcement has been applied to the Granite Gulch viaduct near Granite, Idaho, and about 50 miles east of Spokane, Wash. During recent years, the heavier types of passenger and freight engines have been prohibited from crossing this viaduct, while all engines operating over it have been restricted to a slow speed. The reinforcement eliminates speed restrictions and permits the operation of the heavy engines used on adjacent parts of the line. The decision to reinforce this structure was based on the economy, as determined by estimated costs, over any other method of eliminating the restrictions as to engines and speeds. Comparative costs also determined the method of reinforcement, which was shown to be more economical than any other methods considered. A view of part of the completed structure is given in Fig. 1.

Original Structure—The Granite Gulch viaduct is a single-track structure, 1,169 ft. long, with a maximum height of 110 ft. from base of rail to surface of water. It is on a tangent and on a grade varying from level to 0.38 per cent. There are two girder spans of 31 ft. out to out, on each approach; twelve tower girder spans of 31 ft. and eleven fish-belly girder spans of 61 ft. between the towers. These twelve towers range from 35 ft. 9 in. to 98 ft. 9 in. in height. The approach girder spans are supported on granite masonry abutments, rocker bents and the end tower bents. These two rocker bents are 22 ft. and 28 ft. in height. Fig. 2 shows the general design.

The viaduct, as built in 1893 in connection with a change of line, was designed for a loading of two 116-ton, consolidation 2:8:0 engines, followed by a train load of 3,000 lb. per foot, equivalent to Cooper's E-33 loading. This was the standard for the railway company's bridge design from 1891 to 1897. All metal in the original viaduct is wrought iron, except that the rivets are of rivet steel.

Masonry—Pedestal piers of granite masonry, supporting the tower columns, are built on solid rock, except

FIG. 1—GRANITE GULCH VIADUCT: NORTHERN PACIFIC RY.
Note reinforced columns and bracing. New rocker bent at left. Concrete slab deck.

that the piers for two towers in the lake are on piles 8 to 63 ft. in length, driven through mud to solid rock. Piers founded on rock and on piling average 12 and 16 ft. in height, respectively. Most of these pier foundations were of sufficient size to provide for the additional bearing area of the bases of column reinforcement. For the three towers at each end, however,

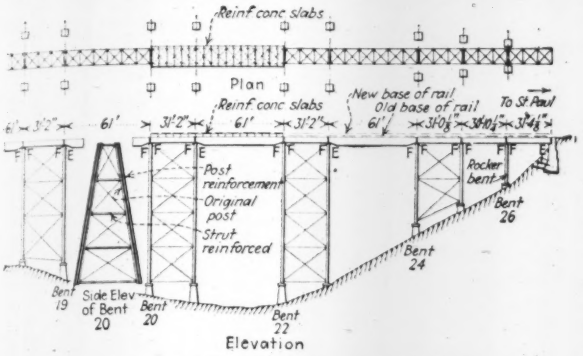


FIG. 2—TYPICAL DESIGN OF VIADUCT

the piers were increased in size by a casing of 1:2:4 concrete, reinforced with vertical bars and ⅜-in. hoops. This casing was 10 in. thick on the outer side and 7 in. on the other three sides.

Reinforcement of Columns—In the twelve towers, the columns have been reinforced by placing additional steel on the outside of the old wrought-iron members and riveting the new steel to the old iron. Each old column consists of two web plates and four angles with double lacing bars on the inner or track side and a cover plate on the opposite or outer side. This construction was reinforced by placing on the outside two steel channels, spaced 9 in. back to back, and connected by one set of double lacing bars on the outside of their flanges, together with gusset plates and diaphragms for the new longitudinal diagonal bracing, as shown in Fig. 3.

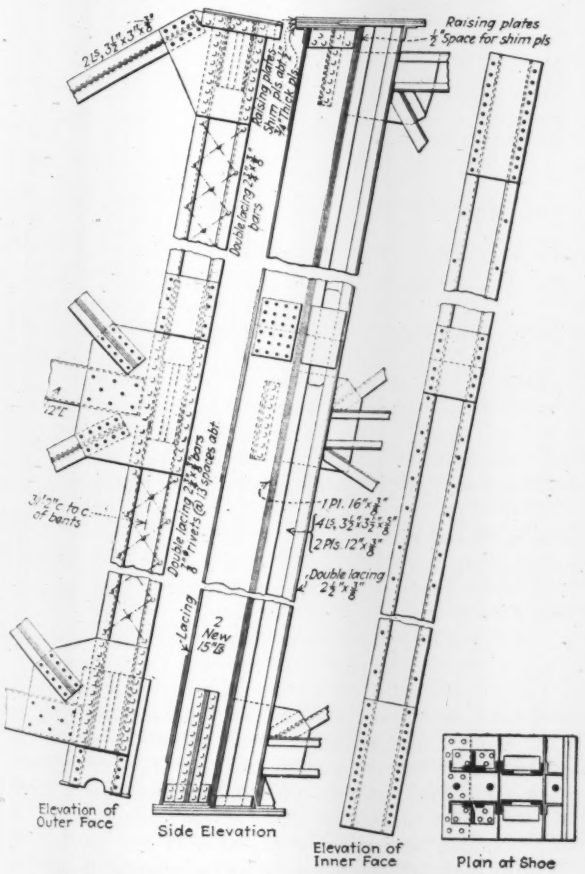


FIG. 3—REINFORCEMENT OF VIADUCT TOWERS

These channels were placed directly on the rivet heads of the old columns. Each third rivet, at an average spacing of 15 in., in the two rows of rivets along the old columns, and in connecting cover plates and angles, was cut out; while at the extreme end of each column about fourteen rivets were cut out in each row. All these rivets were replaced with new long rivets connecting the new steel to the old iron members. Rivet holes in the new steel for these connections were

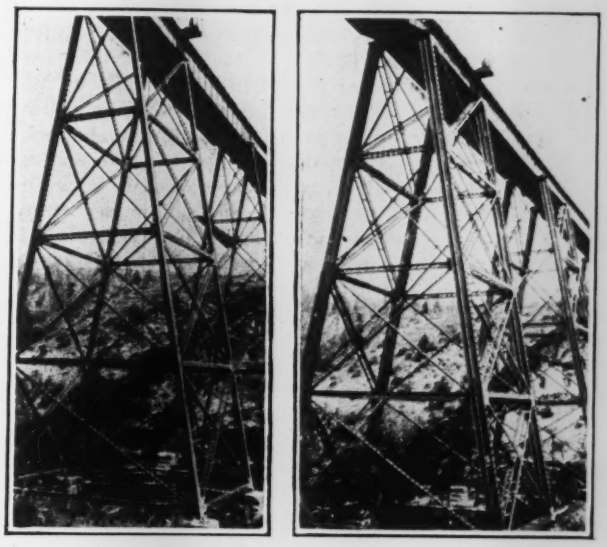


FIG. 4—TOWERS OF GRANITE GULCH VIADUCT

At left: original construction. At right: reinforced construction.

punched in the shop. These rivets were ¾ in. in diameter and less than 1 per cent of the holes required reaming for a larger size rivet on account of unfair holes. The space between the new and old metal was filled at each rivet connection with a ⅞-in. washer 3 in. in diameter, except that at the ends of columns filler plates were used. Reinforcement of the columns and tower bracing is shown in Fig. 3, while Fig. 4 is a

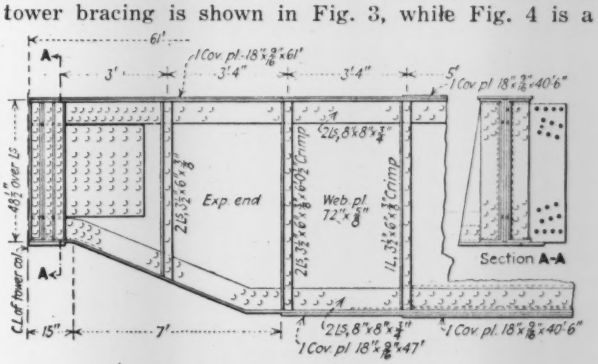


FIG. 5—NEW 61-FT. GIRDERS

comparative view of part of the steelwork in its original form and as reinforced.

In length, the column reinforcement was made ½ in. short at both bottom and top of columns, in order to clear the old column cap and base projections. This space at base of column reinforcing was filled with rust cement rammed compactly into place under the base plates. At the top of the column, reinforcing shim plates of various thicknesses were driven into the space between the projecting ends of the old cap plate and

reinforcing cap plate. On the outer portion, shim plates of various thicknesses were placed to bring the top of the reinforcing cap plate level with the old column cap plate.

For the two rocker bents, the old bents were removed entirely and replaced with new bents of heavier construction.

Reinforcement of Struts and Bracing—The old longitudinal struts are of box lattice section, made up of four angles connected by single lacing bars on the four sides. The old longitudinal diagonals consist of pairs of angles connected with lacing bars. In each panel, the legs of angles in one diagonal are turned out, while in the other diagonal they are turned inward. The longitudinal strut reinforcing consists of a single channel, while that of the diagonals consists of two angles riveted back to back with ⅜-in. thick separators between them. The outstanding legs of diagonal angles were turned in or out, the same as in the old diagonals.

This reinforcing, shown in Figs. 3 and 4, is riveted to gusset plates on the outside of the new channels reinforcing the columns. The strut reinforcing members are connected to the old struts by five tie-plates at both top and bottom of struts and spaced equally along their length. Each new and old diagonal are also connected together by five tie-plates. These tie-plates are secured to the new and old diagonals with two rivets in each plate, and are secured to the old struts with two bolts. Holes for rivet and bolt connections in old members were drilled in the field. The tower crossbracing was not reinforced.

Erection of Tower Reinforcement—No particular difficulties were encountered in erecting the tower reinforcing steel. All new steel was placed by a derrick car, from the deck of the bridge. The work of cutting out old rivets in tower columns and drilling new rivet holes in old longitudinal bracing, as well as all riveting, was done from stagings, 4 ft. wide and 35 ft. long, suspended from deck ties and lowered by means of rope and tackle blocks. They were raised and moved from tower to tower by the derrick car. All work in connection with the reinforcement of the towers was done without interference to regular train service over the viaduct.

Reinforcement of Spans and Deck — The old girder spans with timber bridge-tie deck were entirely removed, and were replaced with new girder spans of heavier design carrying reinforced-concrete deck slabs for ballasted track. The spacing of the old girders was 9 ft. 6 in. c. to c., and that of the new girders was increased to 10 ft. 8 in. in order to place their center lines over the center of gravity of the reinforced columns. The new girders are of the same type as the old girders removed; being 48½ in. deep back to back of angles for 31-ft. girder spans and for the ends of 61-ft. spans, and 72½ in. on the fish-belly portion of 61-ft. spans. In the longer spans, Fig. 5, the girders have ⅝-in. webs, four flange angles 8 x 8 x ¾ in. and cover plates on both chords.

Two section-car refuges are provided, having platforms 7 x 21 ft. on wood joists laid across cantilever brackets bolted to the girders of the tower spans. Twelve smaller refuges for track men have platforms 31½ x 39⅜ in. of plank laid directly upon brackets attached to anchor bolts in the faces of the concrete deck slabs.

Concrete Deck Slabs — Reinforced-concrete slabs to carry ballasted track were precast in a yard at the bridge site. These slabs, Fig. 6, are 14 x 5 ft. in size, 17½ in. thick at the middle and 16½ in. at the sides, adjacent to the curb walls which retain the gravel ballast. Besides being crowned laterally the surface is shaped to form longitudinal drainage planes converging to a 2-in. galvanized iron drain pipe on each side. This crowned and warped surface is given in finishing the concrete with a wood float. A 1:2:4 mix is used, with crushed stone aggregate of ¼-in to 1-in. size; the reinforcement consists of bars and stirrups, and there are two lifting hoops in each slab. The slabs were kept ten days in the forms and were at least 30 days old before being placed on the viaduct. Their weight averages 16,000 lb. per slab.

Sheet lead 3/32 in. thick was placed on the top flanges of the new girders in order to protect the steel from

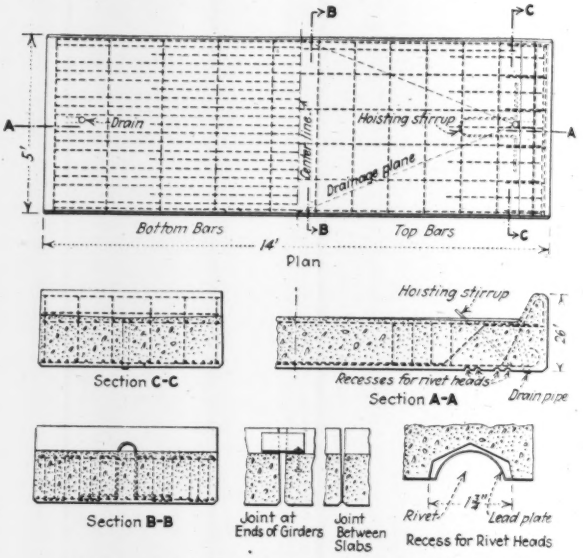


FIG. 6—PRECAST DECK SLABS FOR VIADUCT

rust due to moisture working under the concrete slabs. These lead plates were laid on the girders and carefully shaped over the rivet heads before the spans were placed in the viaduct. When the slabs are placed, they leave joints ⅜-in. wide at bottom and 1⅜ in. at top. The joint is packed with oakum for 1 in. at the bottom and then filled with 1:1 cement mortar. In the bottom of the slab, grooves 1¾ in. wide and ¾ in. deep are formed to fit over the rivet heads and the lead plates. The slab does not rest directly upon the lead, but upon a bed of 1:2 cement-sand mortar about ¼ in. thick, which is placed and spread evenly just before the slab is laid.

Changing the Girder Spans—On completion of the work of reinforcing the viaduct towers, the reconstruction of the spans was undertaken. In this work the daily progress consisted in removing one old girder span and replacing with a new span and concrete deck slabs, with new track ties placed temporarily directly on the slabs. At the ends of the viaduct it was necessary to remove two old girder spans and the rocker bent at the same time, and to replace these with new steel. This work was carried on daily at such times as would avoid delaying operation of trains over the viaduct.

All the new girder spans were assembled complete, with bracing placed and riveted, before being placed in

the viaduct. This was necessary in order to place the deck slabs on the girders at the time of placing the spans, thereby avoiding the extra cost of placing temporary track ties on the new girders to maintain traffic over the bridge, and also the extra cost of riveting the new spans in place in the viaduct. It was desirable also to place the new spans complete in order to decrease the time required for changing the spans. To keep the track connected up, ties were placed temporarily on two lines of 1-in. board, laid under the rails, a thin layer of sand being spread on the slabs to form an even bearing surface for the boards.

The old 61-ft. girder spans were removed and new spans placed by means of two derrick cars, as shown in Fig. 7. Each of the old spans was removed as a unit, without removing bracing, and with the old bridge ties still on the girders. It was then placed on a four-wheel truck and hauled to a sidetrack on the approach. The new span was brought out on a similar truck. Immediately after the new span was in position, the concrete deck slabs were placed with a derrick car. The 31-ft. spans were changed by means of one derrick car.

As the extra depth due to concrete slabs and ballasted track raised the track level on the new spans about 16½ in. above the level of track on the old spans, it was necessary to place a track runoff on the old spans in advance of each new span. This runoff for each 61-ft. span was made by raising the ties on the adjoining old 31-ft. span by beveled timbers on top of the old girders, and also by raising one end of the next old 61-ft. span and placing oak bearing blocks under the girder bearing plates on top of the viaduct columns. This made a runoff in 92 ft. The runoff adjacent to a new 31-ft. span was made by further raising the end of the adjoining old 61-ft. span and placing a longer oak bearing block under each girder, thus making a runoff in 61 ft.

The average time required for making a complete change of girder spans and completing track ready for operation of trains over viaduct was about 2½ hours for a 31-ft. span and about four hours for a 61-ft. span. With the changing of all girder spans completed, the track on the viaduct was further raised, the boards under the ties were removed and washed gravel ballast was placed under the ties to an average depth of 6 in.

Loading and Quantities—The viaduct as reinforced was designed for Cooper's E-60 loading, in accordance with the Northern Pacific Ry. standard specifications, which are closely patterned after the A.R.E.A. specifications. The amount of material used in the reconstruction work was as follows: Concrete in substructure, 63 cu.yd.; concrete in deck slabs, 893 cu.yd.; reinforcing steel in deck slabs, 74 tons; structural steel for tower reinforcement and new rocker bents, 333 tons; structural steel in new girder spans, 613 tons. The weight of the old girder spans removed was 336 tons.

Engineers and Contractors—This viaduct reinforcement work was designed and carried out under the direction of the engineering department of the Northern Pacific Ry.: H. E. Stevens, chief engineer; M. F. Clements, bridge engineer; and H. R. Peterson, resident engineer. New structural steel was furnished by the American Bridge Co., while the Twin City Bridge Co. had the contract for erection.

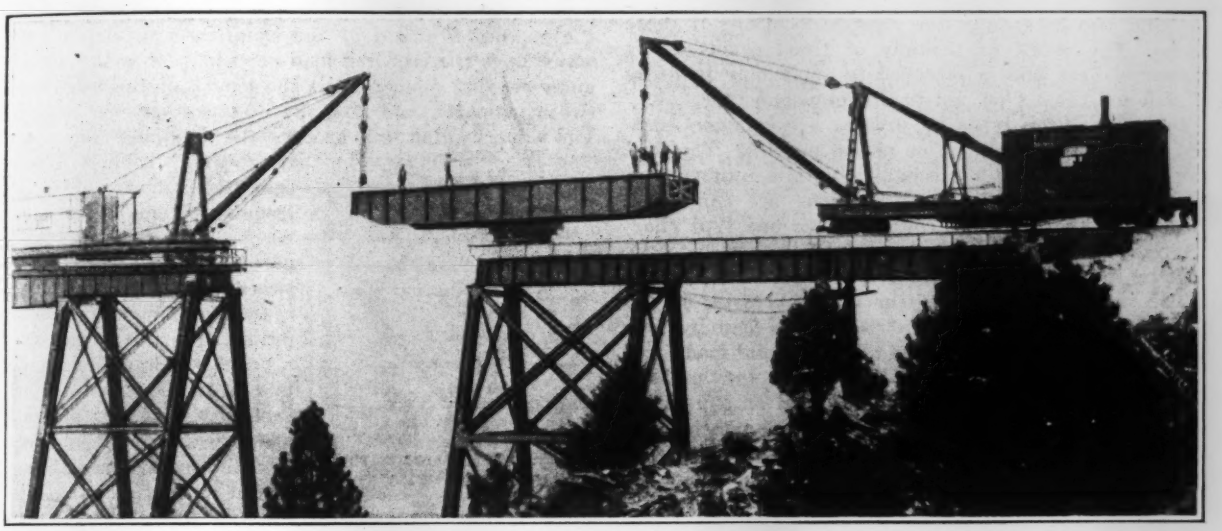


FIG. 7—PLACING NEW 61-FT. SPAN

Fault at Dam Site Shows Longitudinal Movement

Examination of the site of the proposed Stony Gorge dam for supplementary supply to the Orland reclamation project in California has disclosed unsatisfactory conditions, according to a statement just issued by the Bureau of Reclamation. C. D. Hulin, geologist, University of California, found upon detail geological examination that the gorge at the site has been formed by erosion along a fault line cutting across hills of sandstone and conglomerate, and that the south side of this fault has moved east about 150 ft. relative to the north side. There is possibility of future lateral movement at the fault, and settlement of part of the dam after construction. The Bureau of Reclamation is planning to proceed with the construction of the dam at an early date, however. Very favorable conditions are found at another dam site of the bureau, that of the Gibson dam to be built for the Sun River project (Montana). This is to be an arch dam 175 ft. high above streambed. C. H. Clapp, University of Montana, who made the geological examination of the site, finds the rock of sufficient strength and otherwise in all respects suitable for the construction of a high arch dam, the rock to be made tight with cement grouting.

Live-Loads for Floors Supporting Printing Presses

Assumed Press Weight Distribution as Affecting Maximum Bending Moments and Shears —Equivalent Uniform Loads

By E. L. Verveer
Structural Engineer, New York City

DESIGNING floors to be used for supporting printing presses presents a special problem because the weights of the presses are carried to the floor as concentrated loads of variable and sometimes high intensities and also because of the relative locations of these loads. The result of a study of these conditions is presented here and is intended to apply only to floors of slab-and-beam type, not to the long-span type.

Presses—Three types of presses are common—flat-bed, rotary and small job or platen presses. The first two types differ only in mechanical details, unimportant as far as floor design considerations are concerned. They may, therefore, be considered as one type characterized by the fact that the weight is carried to the floor by the long sides of the frame base.

The weights of small job or platen presses, on the other hand, are ordinarily carried to the floor by four legs and the floor loads may be taken as point loads.

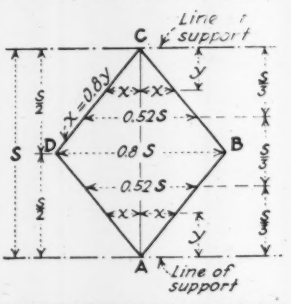
Weight Distributions—For flat-bed or rotary presses, one-half of the weight may be assumed as a uniform load on each of the two sides. The maximum load on any beam will occur when one side of the frame is directly over the beam and parallel to it; one-half the weight of the press will then be supported by the beam except when the span between beams is greater than the width of the frame, in which case a portion of the half-weight on the opposite parallel side of the frame will also be transmitted to the beam under consideration. In such event the amount transmitted will be the half-weight multiplied by its distance from the opposite beam divided by the distance between beams. Also if the longitudinal center-line of the press is over and parallel to the beam in question, and the distance between beams is equal to or greater than the width of the frame, but is less than one-half the width of the frame plus the transverse distance between presses, the same maximum load occurs on the beam as when one side of the frame is over and parallel to it.

TABLE I—ROTARY AND FLAT-BED PRESSES—EQUIVALENT UNIFORM LOADS ON BEAMS AND GIRDERS, POUNDS PER SQUARE FOOT

Press Weight, Tons	Span of Beam, Ft.	Spacing of Beams, Ft. 5	6	7	8	Press Weight, Tons	Span of Beam, Ft.	Spacing of Beams, Ft. 5	6	7	8
27.1	15	284	237	203	215	11	15	170	145	140	148
	20	285	237	203	215		20	150	130	125	130
	25	269	224	192	203		25	130	113	110	118
25.0	15	261	218	195	205	10	15	157	141	137	141
	20	262	219	195	207		20	139	124	120	124
	25	248	207	183	195		25	120	109	105	109
22.1	15	259	216	198	209	9	15	150	139	135	140
	20	255	213	195	206		20	130	123	117	119
	25	247	204	190	198		25	112	106	103	107
19.6	15	239	199	195	202	8	15	146	137	130	129
	20	231	193	189	196		20	120	116	111	108
	25	211	176	172	191		25	110	105	100	105
16.8	15	224	187	160	170	7	15	140	132	125	125
	20	210	175	150	158		20	117	110	103	103
	25	188	157	134	142		25	115	108	102	102
16.3	15	216	181	155	172	6	15	131	123	121	120
	20	203	169	145	160		20	108	101	99	98
	25	182	151	130	144		25	105	98	96	95
12.7	15	185	155	139	150	5	15	110	104	103	93
	20	166	139	123	136		20	92	86	85	78
	25	147	123	111	120		25	81	77	76	69
12.2	15	179	149	140	148	4	15	103	95	95	94
	20	162	135	126	135		20	84	77	77	75
	25	146	122	115	122		25	69	67	68	66

For the purpose of determining the maximum beam loads it is assumed that the presses are so placed that there will be a clear space of 3 ft. between their over-all widths and 4 ft. between their over-all lengths. Under such an arrangement of presses, the beam will be uniformly loaded, either totally or partially depending upon whether the frame's base is as long as the beam or not.

The equivalent uniformly distributed load per square foot of floor is then obtained by dividing the total load on the beam, if it is fully loaded, by the length of the beam between its supports multiplied by the distance between beams. If the beam is only partially loaded, the loading is found by the equation $w = 8M/Sl^2$, in which w is the required load per sq.ft., M is the maximum bending moment, l is the length of the beam between supports, and S is the distance between beams. The same loading will produce the maximum shear on the beam. Table I gives the equivalent uniform loads for beams 15, 20 and 25 ft. long between supports and for widths between beams from 5 to 8 ft.



DISTRIBUTION OF JOB-PRESS LOAD CONCENTRATIONS

In designing for installations of small job presses a beam will have its maximum load when two legs of each of a series of presses are directly over it and the resulting point loads are so placed as to fulfill the criteria for maximum bending moment and shear. As in the case of rotary and flat-bed presses, a portion of the loads from the other two legs of each press is brought over to the beam in question but as concentrated instead of uniform loads. The assumption is made that the presses are so placed as to allow a clearance of 1 ft. 7½ in. between their over-all widths and 3 ft. between their over-all lengths. As the distances between the point loads are small, the unit floor loads obtained from the maximum bending moments will be practically the same as those required for the maximum shears on the beam. The equivalent unit floor loads are obtained from the equation previously given. Table II gives the floor loads per sq.ft. for platen presses for beams 15, 20 and 25 ft. between supports, spaced 5 to 8 ft. apart.

Floor Slabs—The strength of the slab is determined primarily from the maximum bending moment produced by the load upon it. When supporting rotary or flat-bed presses, this load is a uniformly distributed one, extending the length of the press frame. The slab may be designed as a beam one foot wide whose length is the distance between supporting beams and which carries concentrated loads of one-half the weight of the press per foot length of frame.

The positions of the loads that produce the maximum bending moment will depend upon whether the slab is (1) simply supported, (2) free along one side and continuous at the other, or (3) continuous over both supports. For the first condition, the positions of the loads are the same as for simple beams. For the second condition, the maximum bending moment usually occurs when one side of the frame is about four-tenths the span of the slab from the free side. For continuous

TABLE II—PLATEN PRESSES—EQUIVALENT UNIFORM LOADS ON BEAMS AND GIRDERS, POUNDS PER SQUARE FOOT

Press Weight, Lb.	Span of Beam, Ft.	Spacing of Beams, Ft. 5	6	7	8	Press Weight, Tons	Span of Beam, Ft.	Spacing of Beams, Ft. 5	6	7	8
3,400	15	81	76	73	68	1,500	15	44	41	39	36
	20	81	76	73	68		20	41	37	36	33
	25	81	76	73	68		25	43	37	37	35
2,600	15	62	58	55	52	1,050	15	35	34	37	38
	20	62	58	55	52		20	34	32	30	31
	25	62	58	55	52		25	34	33	31	32
2,100	15	50	47	45	42						
	20	50	47	45	42						
	25	50	47	45	42						

slabs, the negative bending moment at the support is, as a rule, a maximum when the support is on the longitudinal center-line of the press frame. The equivalent uniform load that will cause the same maximum bending moment as do the concentrated loads may be computed as $8M/S^2$, $10M/S^2$, and $12M/S^2$, for the three conditions at supports respectively; M being the moment per foot width of slab and S the span of the slab. Table III gives the equivalent unit live-loads for slabs having supports 5 to 8 ft. apart for the three above-named conditions of support.

Since for small job presses the loads on the slab are point loads, the method of determining the equivalent unit live-loads is approximate. The writer bases his method upon the results of tests on concrete slabs made by Morris, Smith, McCormick, Slater and Goldbeck, and reported by the writer in *Engineering News-Record*, Feb. 9, 1922, p. 238. From these tests, it was found that a point load placed on a floor slab mid-way between its supports may be considered as uniformly distributed in the direction parallel to the supports for a length equal to 0.8 the distance between supports. Likewise, for two loads at the third points, the uniform distribution may be taken as 0.52 of the distance. Expressed algebraically, if S is the distance between supports, P the point load, and e and e_1 the distances over which P may be considered as uniformly distributed, $e = 0.8\ S$ for the first case and $e_1 = 0.52\ S$ for the second case.

If the values of e and e_1 are plotted for any particular span, lines drawn through the ends of e and e_1 will practically intersect the supports at the center of the length e. This is shown in the drawing. For any distance y from A or C along the line AC to where a point load is placed, the length x will give the distance to the right and left of the load over which P may be considered as uniformly distributed. This value of x may be found from the equation $x = 0.8y$.

For a single load the equivalent uniform distribution will extend over a length $e_1 = 2x$. In the case of platen presses placed in multiples, when x is greater than one-half the distance between the legs of a press, $e_x = 2x + a$, where a is the distance between legs. $P/2x$ or $P/(2x + a)$, as the case may be, will give the concentrated loads per unit width of slab for the span S.

The floor slab may then be designed as a beam of unit width and length S, for the three different conditions at supports mentioned before and carrying concentrated loads so placed as to fulfill the criteria for maximum bending moment and shear. The equivalent uniform loads are found from the maximum bending moments by applying the equations previously given for rotary and flat-bed presses for the three conditions at supports. These floor loads are given in Table IV.

Dynamic Effect—The writer knows of no published data regarding the effect produced on the floors by the dynamic impulses of the presses. The general effect, however, is a vibratory one. The speed of rotary presses is considerably greater than that of flat-bed or platen presses. Hence, the intervals of vibration of the former are shorter and the number of vibrations greater per unit of time than those of the latter. The dynamic effect, therefore, is greatest for rotary presses. There is also a lateral vibration of considerable intensity. In a flat-bed press the type bed moving backward and forward exerts an alternating horizontal thrust on the frame every time it reaches its extreme position. This thrust is transmitted by the frame to the floor system. The pivoted backs of small job presses, pressing against the platen and then swinging backwards, cause a downward pressure on the floor.

It follows from the preceding that in addition to any increase of material provided for dynamic impulse, it is also essential that the floor system be made as rigid

TABLE III—ROTARY AND FLAT-BED PRESSES—EQUIVALENT UNIFORM LOADS ON FLOOR SLABS, POUNDS PER SQUARE FOOT

Slab Simply Supported					Slab One End Free, Other End Continuous					Slab Continuous				
Press Weight, Tons	Span of Floor Slab, Ft. 5	6	7	8	Press Weight, Tons	Span of Floor Slab, Ft. 5	6	7	8	Press Weight, Tons	Span of Floor Slab, Ft. 5	6	7	8
27.1	560	470	408	352	27.1	550	420	347	307	27.1	336	386	383	356
25	520	435	373	326	25	490	380	320	287	25	355	387	363	336
22.1	516	430	368	322	22.1	477	374	319	287	22.1	377	389	368	329
19.6	478	400	340	300	19.6	427	343	298	273	19.6	392	362	350	306
16.8	450	374	320	280	16.8	440	336	277	244	16.8	291	307	298	282
16.3	433	360	310	270	16.3	409	316	267	238	16.3	290	318	301	280
12.7	375	313	268	235	12.7	353	274	230	206	12.7	267	280	260	243
12.2	360	300	257	225	12.2	327	260	224	203	12.2	280	280	258	231
11	350	290	250	217	11	316	250	220	202	11	300	280	256	223
10	330	280	240	208	10	292	241	215	198	10	292	270	240	206
9	325	270	230	204	9	282	238	213	202	9	300	280	238	206
8	310	260	223	195	8	270	240	213	200	8	300	265	228	194
7	300	250	215	180	7	260	230	215	200	7	300	250	200	185
6	295	245	210	180	6	260	230	215	200	6	300	250	204	185
5	225	185	160	150	5	200	176	163	160	5	250	190	160	160
4	220	185	160	150	4	200	176	163	160	4	230	190	160	170

TABLE IV—PLATEN PRESSES—EQUIVALENT UNIFORM LOADS FOR FLOOR SLABS, POUNDS PER SQUARE FOOT

Press Weight, Lb.	Span, Ft.	Equivalent Uniform Load—Slab Simply Supported	Slab One End Free, Other End Continuous	Slab Continuous
3,400	5	183	191	210
	6	136	150	170
	7	116	124	144
	8	122	140	156
2,600	5	140	146	160
	6	104	115	130
	7	89	95	110
	8	93	107	119
2,100	5	113	118	130
	6	84	93	105
	7	72	77	89
	8	75	86	96
1,500	5	86	85	98
	6	70	72	80
	7	70	80	88
	8	57	67	73
1,050	5	64	65	73
	6	51	52	58
	7	50	58	68
	8	48	50	56

as possible, especially the connections of beams and girders to columns.

Conclusions—For general use, the writer suggests the loads per sq.ft. shown in the following table:

Press Weight, Tons	For Beams and Girders, Lb.	For Floor Slabs, Lb.	Press Weight, Tons	For Beams and Girders, Lb.	For Floor Slabs, Lb.
1½	60	150	10	175	350
4	100	250	13	200	375
6	125	300	20	250	450
8	150	325	30	300	575

Presses weighing more than 30 tons each should rest on independent foundations carried to the ground.

State Highway Departments Spent $650,000,000 in 1925

THE TOTAL expenditure by state highway departments in the United States in 1925 for road and bridge construction on the several state highway systems amounted to $649,125,101, according to reports from the highway departments just compiled by the Bureau of Public Roads, U. S. Department of Agriculture. Of the total expenditure 59.6 per cent was spent for road and bridge construction, 18.4 per cent for maintenance, and 3.5 per cent for materials and equipment. Administration and engineering costs accounted for 4.7 per cent of the total, interest and principal payments on bonds 7.8 per cent, and miscellaneous expenditures amounted to 6 per cent.

To meet these expenses the highway departments received from various sources during the year a total income of $780,081,292 of which $115,656,721 was available as a balance from the previous year's operations, so that the amount of money raised during the year was only $664,424,571. Of the latter amount 43.5 per cent was raised by means of motor-vehicle license fees and gasoline taxes, 30 per cent from the former and the balance from the latter. The sale of bonds realized 21.3 per cent of the total for the year, and federal aid amounted to 13.9 per cent. Funds transferred to the state by the counties and other local governments amounted to 10.8 per cent, and the balance was made up of funds derived from special highway taxes and appropriations and from miscellaneous sources in the following percentages: Taxes, 3.3; appropriations, 5, and miscellaneous 2.2.

Although the year's expenditures were slightly greater than the previous year's total of $605,665,207, the balance of $130,956,191 carried over into the current year was even greater than the amount of unexpended funds carried over from 1924. The rate of construction remained about the same as in previous years.

There was a remarkable increase in the percentage of the total highway income derived from motor-vehicle and gasoline taxes, and a falling off in the percentage representing real and personal property taxation. There has been a steady tendency in this direction since 1921. In that year the combined income from motor-vehicle licenses and gasoline taxes amounted to 25.9 per cent, the gas tax revenue amounting to less than one per cent. In 1925 the income produced from these sources was 43.5 per cent of the year's total and the gas taxes alone amounted to 13.5 per cent.

In the same period taxes on property specifically for road purposes have dropped from 11.2 to 3.3 per cent of the year's total income. Including the income from appropriations and miscellaneous sources, most of which is raised indirectly by property taxation, the 1921 percentage was 20.7 and the 1925 percentage was 10.5.

Funds raised by the sale of bonds were also a smaller percentage of the total in 1925 than in 1921, being 21.3 in 1925 as compared with 27.8 in 1921.

Expenditures of the state highway departments in 1925, not counting county and local expenditures, are:

Alabama	$10,917,204	Nevada	$3,055,959
Arizona	2,442,947	New Hampshire	4,027,241
Arkansas	11,200,000	New Jersey	23,939,454
California	18,090,728	New Mexico	3,322,548
Colorado	5,564,590	New York	49,368,770
Connecticut	8,611,936	North Carolina	32,588,514
Delaware	3,492,841	North Dakota	1,862,348
Florida	8,483,752	Ohio	24,086,289
Georgia	7,902,428	Oklahoma	12,937,673
Idaho	3,636,681	Oregon	15,553,453
Illinois	36,375,983	Pennsylvania	62,294,366
Indiana	14,517,794	Rhode Island	3,045,859
Iowa	14,107,798	South Carolina	9,132,933
Kansas	7,407,369	South Dakota	6,328,176
Kentucky	14,916,316	Tennessee	14,379,189
Louisiana	8,610,624	Texas	19,985,007
Maine	7,105,389	Utah	4,123,798
Maryland	12,024,781	Vermont	3,618,327
Massachusetts	12,880,700	Virginia	14,071,555
Michigan	36,138,549	Washington	7,845,566
Minnesota	17,962,567	West Virginia	16,138,729
Mississippi	4,795,192	Wisconsin	7,784,733
Missouri	31,593,937	Wyoming	3,973,494
Montana	1,267,242		
Nebraska	5,563,752	Total	$649,125,101

Novel Plan for Applying Asphalt Filler on a Clay Pipe Line

Collapsible Pneumatic Inside Forms Used—Half of Joints Poured on Bank and Half in Trench

BY COULSEN C. WRIGHT
U. S. Dept. of Agriculture, Bureau of Plant Industry

AN 8-in. vitrified clay pipe line, in which a part of the joints were sealed with hot asphaltic material as a filler, has just been completed at the State Irrigation Branch Experiment Station, Prosser, Washington. In this new process for sealing bell-and-spigot pipe joints special collapsible forms were used which prevented the hot joint material from entering the inside of the pipe and at the same time served as an aid in aligning the pipe sections. The asphalt was hand poured from buckets.

The line was laid as an inverted siphon across a draw and the maximum head on the pipe was 12.2 ft. There were 248 joints in the line, 27 sealed with hot "jointite," 58 sealed with a mixture of pure asphalt and mica sand in equal parts mixed while heating, and the remaining 163 sealed with cement mortar (1:1½ with 10 per cent hydrated lime). For the latter bell-less vitrified clay pipe was used, the ends being scored on the outside for bonding the cement collar and the end of each pipe section carrying an annular groove about ¼ in. deep to receive the mortar.

The filling of the asphalt joints consisted of two processes: (1) Half of the joints were poured on the bank before the pipe was laid and (2) the other half were filled in place in the trench. No oakum or calking was used, the joint being completely filled with asphalt.

The collapsible forms used inside of the pipe were of two types, one for joining pipe sections on the bank in a vertical position and one for joining the two-joint sections together in the trench in a horizontal position. The bank-form is to be used only for pipe which is small enough to be handled easily. In laying large heavy pipe the trench-form only is to be used.

The construction of the form itself is the same in both types (Fig. 2). It consists of a center wooden

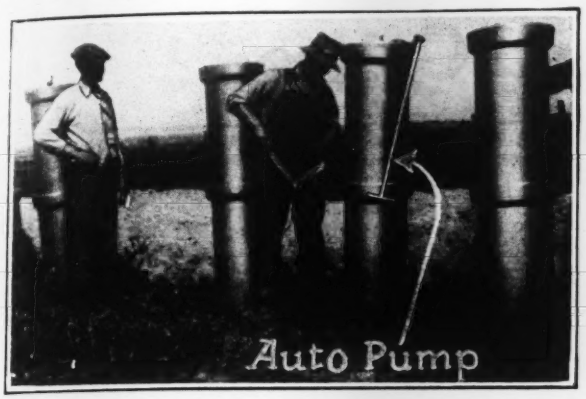


FIG. 1—POURING HOT ASPHALT IN JOINTS ON BANK OF TRENCH

core shaped somewhat like a spool. A pneumatic rubber tube is wound around this spool and surrounded on the outside by a layer of insulating material which protects it from the hot asphalt filler. Around this is a layer of hair felt which is lubricated on the outside with wet clay or graphite. Air is pumped into the rubber tube through a ¼-in. pipe of proper length which extends from the center of the wooden core to the end of the pipe section. One end of this ¼-in. pipe is soldered to the valve stem of the tube and the other attached to an auto pump. After the joint is poured and set, the air in the form is released by means of an air valve at the end of the pipe and the form withdrawn.

The trench-form differs from the bank-form in that ¾-in. pipe, into which an extension rod is telescoped, extends through the spool part of the form. This extension rod projects forward through the two succeeding sections of pipe to be laid. These section joints are prepared for pouring while the hot joint material is cooling in the last two joints poured. When everything is ready, a pull on the end of the extension rod compresses a spring on the end of the ¾-in. pipe, opens the air release valve and the deflated forms are pulled ahead into position for the next joints. As soon as the pull on the extension rod stops, the spring automatically closes the air release valve and the extension rod can be telescoped into the pipe and out of the way until it is needed for the next pull.

Certain precautions need to be observed in using these forms with the asphalt-filler. (1) The pipe ends must be clean. One way of cleaning them is to brush them with a small paint brush dipped in gasoline. (2) The filler must be hot—very hot. (3) The form must be thoroughly lubricated and tightly inflated against the inside of the pipe. (4) Partial backfilling of the trench should immediately follow the pouring.

Water was turned into the line immediately after the last joint was poured and there were no leaks in the asphalt-filled joints. The advantages claimed for this joint are: flexibility, proper smooth alignment between pipe sections, a complete filling of the bell with asphalt, thus increasing durability and tightness, and greater ease and speed in laying, thus reducing the cost.

This asphalt joint and the forms were developed by A. E. Rasmussen, Yakima, Washington. Patent rights on the forms have been applied for.

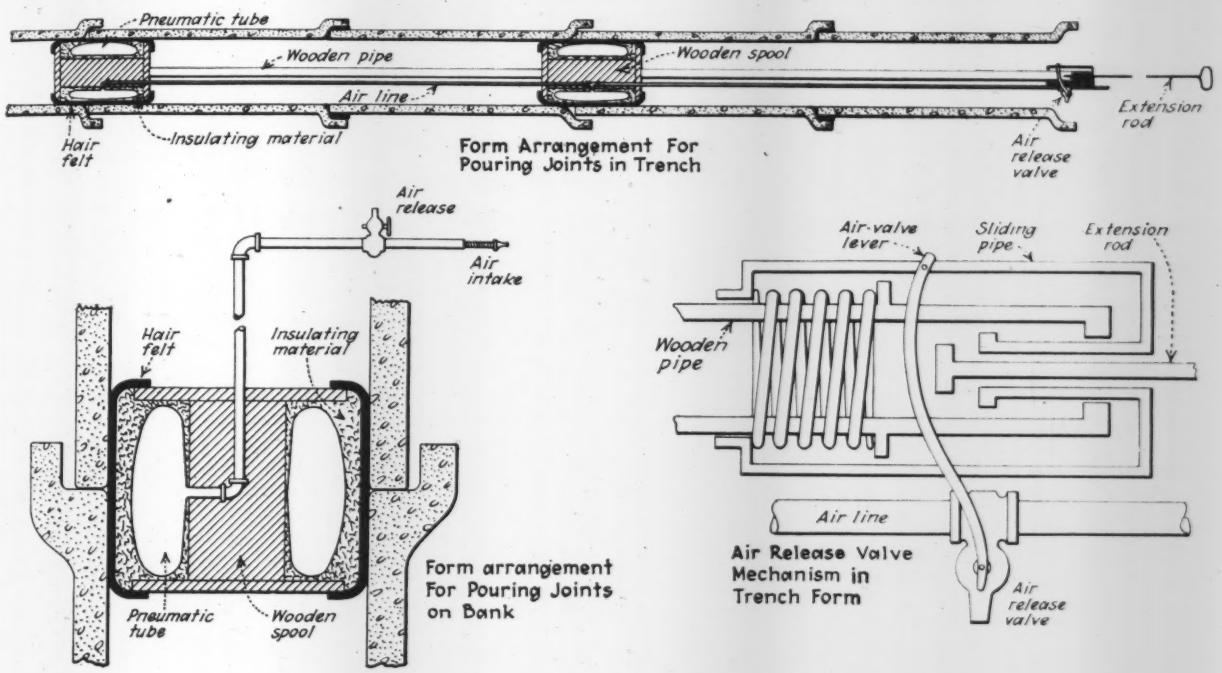


FIG. 2—DETAILS OF INSIDE FORMS USED IN JOINTING VITRIFIED CLAY PIPE WITH ASPHALT

Federal-Aid Roads Add 3,338 Miles in Year

An addition of 3,338 miles was made to the federal aid highway system during the year ending Sept. 23, 1926, according to a statement made by the American Road Builders' Association. The total mileage under the system approved by the United States Bureau of Public Roads now is 182,135 miles, of which approximately 140,000 miles have already been improved to some degree.

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Work-Record Forms on Drainage Ditching

FOR records of cost of construction work on the Elk Chute Drainage District, in Missouri, done under the cost-plus system, a complete cost-accounting system was devised by the engineers. In addition to the forms for record of materials ordered and for distribution of costs to the several machines and operations, there were three reports as to the field work. Two of these are shown herewith.

The daily report of excavator operation, Fig. 1, is

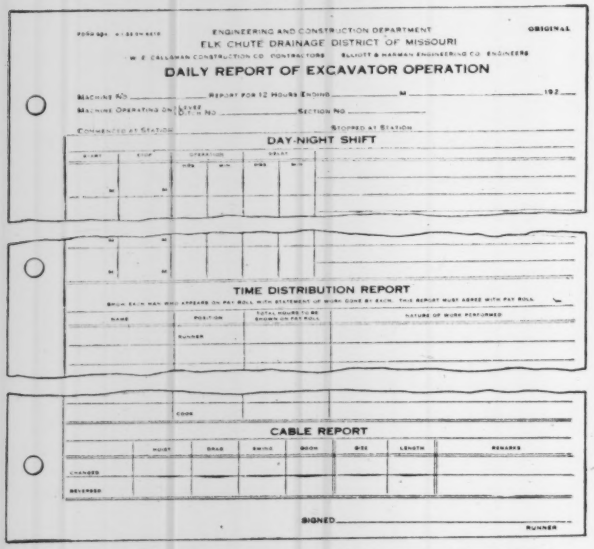
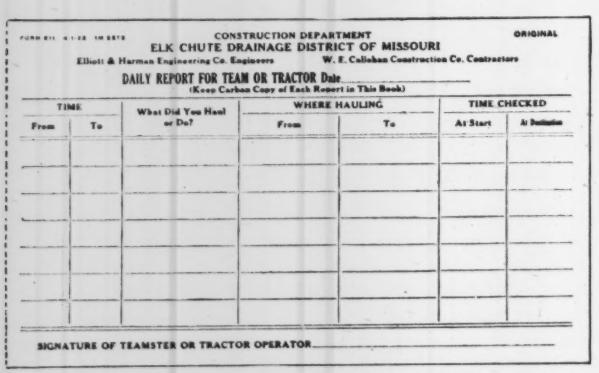

ENGINEERING AND CONSTRUCTION DEPARTMENT — ORIGINAL
ELK CHUTE DRAINAGE DISTRICT OF MISSOURI
W. E. CALLAHAN CONSTRUCTION CO. CONTRACTORS — ELLIOTT & HARMAN ENGINEERING CO. ENGINEERS
DAILY REPORT OF EXCAVATOR OPERATION
DAY-NIGHT SHIFT
TIME DISTRIBUTION REPORT
CABLE REPORT
SIGNED _____ RUNNER

FIG. 1—DAILY REPORT OF EXCAVATOR OPERATION

in duplicate, with sheets 8½x11 in., punched at one side for a three-ring loose-leaf binder. The original (white) is sent by the operator to the accounting office, where it is retained in the loose-leaf binder until the pay-roll is posted, after which it is transferred to a permanent binder. The duplicate (blue) is retained at the machine for reference, these copies being removed from the binder at the end of the month and tied in a bundle. A daily time report for each machine, made out by the inspector or foreman, is of the same size, but punched at the top for a two-ring binder. This has a heading "Daily Time Slip, Machine No. ——", and is ruled in three columns for name of operator, number of hours allowed, and nature of work performed. The original (white) goes to the accounting office and the duplicate (blue) is retained at the machine.


CONSTRUCTION DEPARTMENT — ORIGINAL
ELK CHUTE DRAINAGE DISTRICT OF MISSOURI
Elliott & Harman Engineering Co. Engineers — W. E. Callahan Construction Co. Contractors
DAILY REPORT FOR TEAM OR TRACTOR Date _____
(Keep Carbon Copy of Each Report in This Book)

TIME		What Did You Haul or Do?	WHERE HAULING		TIME CHECKED	
From	To		From	To	At Start	At Destination

SIGNATURE OF TEAMSTER OR TRACTOR OPERATOR _____

FIG. 2—DAILY REPORT FOR TEAM OR TRACTOR

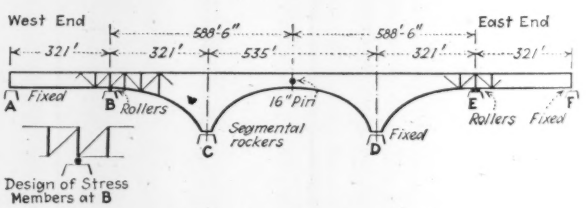
For team and tractor work, there is a report 3½x6 in., Fig. 2, in duplicate, bound in book form for the foreman's use, with about 25 sets to a book. The original (white) is given to the teamster or operator; the carbon copy (yellow) is retained in the book, which is sent to the accounting office when filled.

This drainage work was done by the W. E. Callahan Construction Co., Dallas, Tex. The accounting system was devised by the Elliott & Harman Engineering Co., Peoria, Ill., as engineers in charge for the Elk Chute Drainage District.

Steel Arch Closure Effected with Aid of Temperature Changes

CLOSURE of the central steel arch span, 535 ft. long, in the Ross Island bridge across the Willamette River at Portland, Ore., was recently effected without the use of jacks, the required 2½-in. movement at the crown being made by taking advantage of the daily temperature changes. The main arch in this bridge is flanked on either side by a 321-ft. span continuous with the arch over the main piers, having expansion and fixed bearings as shown in the accompanying sketch.

On account of the necessity of keeping a clear channel the arch was erected without falsework by cantilever-



SKETCH SHOWING DIMENSIONS OF ROSS ISLAND BRIDGE STEELWORK

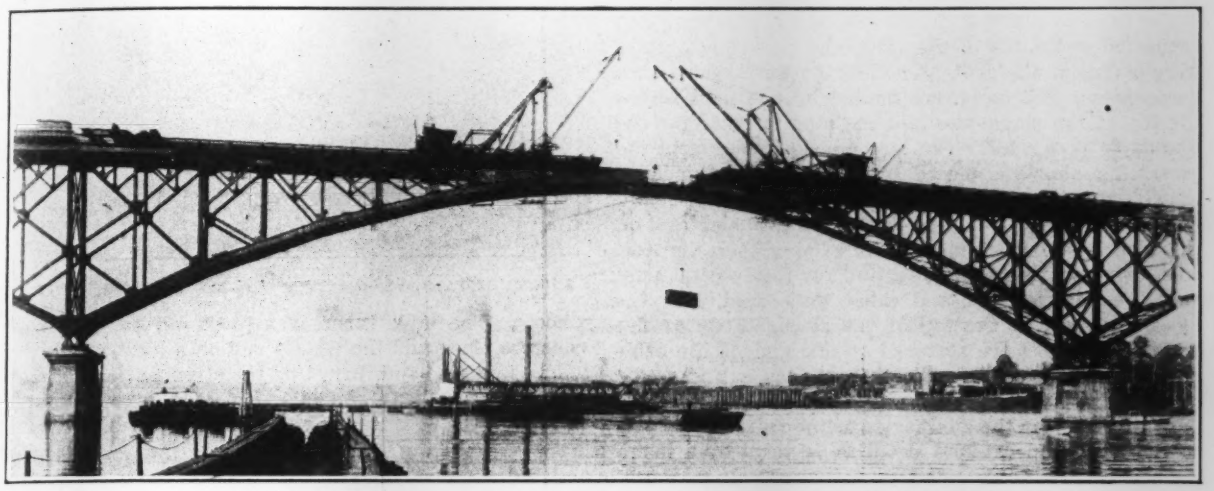
ing out from both approaches. When erection was started, in anticipation of the problem of making the final closure, the erectors set back the steel at *B* and *C* about 2½ in. so that the closing piece at the crown would be short by that length. This was done with the idea of using daily temperature changes to make possible the insertion of the pin at the crown. Final connection was made with the use of a 16-in. hollow, cast-steel pin.

When the time for final closure came the free end at *B* was blocked so that all the expansion over the length of half the arch plus the side span, a total of 588 ft., 6 in., would be toward the crown of the arch.

Two inches was the total expansion that could be obtained in this manner due to the small variation in daily temperature. The remaining ½ in. was obtained as

follows: Heavy links were temporarily bolted into place at the crown fastening the free end of the arch span to the half fixed at point *B*, making it impossible for the gap to open when the span shortened in lower temperature at night.

This changed the position of the free span and the next day additional shims were put in at point *B* and the daily temperature rise forced closure. Two traveling derricks were moved up close to the gap so that the deflection due to their combined weight of 200 tons helped in making the closure.



CENTRAL ARCH OF THE ROSS ISLAND BRIDGE AT PORTLAND, ORE.

The contract for the construction of this bridge was carried out by Booth & Pomeroy, Inc., Portland, Ore., under the direction of J. H. Pomeroy, who worked out the method described in the foregoing.

Placing Air-Hose Line in Steep Mountainous Country

BY DANIEL MCFARLAND
Storrie, Calif.

IN BUILDING the tunnel from Adit to Grizzly Camp for the Feather River Power Co. located at Storrie, Plumas County, Calif., it was necessary to lay an auxiliary air line from the main line on the Adit side to the Grizzly side of the ridge in order that work might be carried on at both ends of the tunnel. The main air line is located just above the railroad grade on the Adit side at the level of the tunnel. Immediately above this track the ridge rises at an angle that averages about 40 deg. to a height of 800 ft. above the tunnel level. The Adit side of the ridge was thickly covered by brush and rock.

In preparation a T-joint was placed on the end of the main air pipe line and next to this joint an air driven tugger-hoist was anchored on the side of the ridge just above the railroad grade. A plug was placed in the horizontal opening of the T-joint for draining any water from the pipe. Four hundred feet above the tugger-hoist a snatch block was anchored to a tree and 700 ft. of six-strand, 19-ply plough-steel cable was passed through the block and placed on the drum of the hoist. A 150-ft. air hose was connected to the vertical opening of the T-joint to feed the hoist and by means of the hoist a 100-ft. section made up of five lengths of 3-in. standard black pipe with a valve at a convenient point for controlling the air flow was laid in place up the side of the ridge. The air hose was then disconnected and the section screwed in its place on the vertical opening of the T-joint, the air hose being placed on the line again at the end of this section. The remainder of the 250 lengths of 3-in. pipe (approximately 20 ft. to each length) which were to compose the auxiliary line was made into loosely joined sections of four lengths each. Each of these sections was in turn fastened to the hoist cable by placing a 3-in. to 1-in. bell-shaped reducer on the end of the section and fastening the cable to the inside of the reducer by means of a cable clamp, the purpose of the reducer being to eliminate sharp corners that might catch on brush and rocks. In this manner each section was hauled to the snatch block by the tugger hoist and laid at a slant on the hillside to keep it from sliding back to the starting point. This being completed, it was necessary to raise the hoist itself to a new position.

To accomplish this, the end of the cable was anchored to a tree near the hoist, and the hoist was made to pull itself up the slope as far as the length of the hose would allow. Before it could be moved farther, it was necessary to take off the air hose, screw a section of pipe on the first 100-ft. section of the auxiliary line, and replace the air hose on the air line at the end of this new section. This gave sufficient play in the air line for the hoist to be raised as far as the snatch block would permit. After anchoring the hoist again and moving the snatch block to a new position 400 ft. above the hoist on the slope, the sections of pipe were ready to be moved to a new position on the slope.

This process was carried out until the sections were within 400 or 500 ft. of the top of the ridge where the process was changed. At this point the hoist was raised as before to the top of the ridge and anchored, and the snatch block was placed in a tree near the hoist in order that the pipe might clear the top of the hill when drawn up by the cable. For this distance, then, the sections were pulled straight up the slope to the hoist with the cable passing through the raised snatch block to form a high line.

In this manner, the pipe for the auxiliary line were laid in position up the slope and the remainder placed

at the top of the ridge for further distribution. It was first planned to tie a drag rope on the cable end to bring it back down the slope for a new section of pipe, but the brush and rock were so thick that it was necessary to send a man up with each section of pipe to keep it free from snags and carry the end of the cable back to the hoist or starting position. Five men started carrying out this operation, but on account of the difficult climb, it was necessary to employ two more as the work progressed up the slope to relieve the men climbing up.

For further distribution the sections of pipe were disconnected at the top of the ridge and thread protectors were placed on the ends. The lengths were loaded on a horse-drawn sled and were hauled by one man across the top of the ridge who laid the pipe in place for the line as he proceeded. This process continued until the remaining pipe was placed at the top of the slope on the Grizzly side of the ridge.

The lowering of the pipe down to the tunnel level on this slope was much simpler than raising it on the Adit side, only two men being required for this work. Here only the snatch block and cable were used with the block anchored at the top of the slope. Four or five lengths of pipe were fastened to one end of the cable and the two men rode the other end as a brake, and allowed the pipe to slide down the slope into position.

In this manner the auxiliary air line from Adit Camp to Grizzly Camp was put down in 10 days by a maximum of 7 men while going up the slope. It might be added that two other valves were placed in the line at convenient places and that wherever a bend in the pipe was necessary, fittings were used instead of heating and bending the pipe. This was done to eliminate danger of setting the brush afire. The work progressed smoothly and the line has been giving good service since its installation.

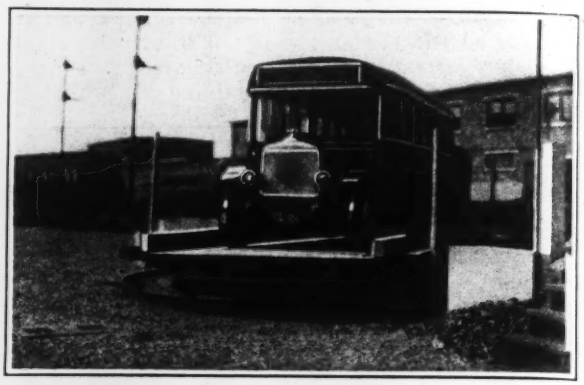
Truck Turntable Aids Railroad in Giving Trainside Bus Service

WHEN the Baltimore and Ohio R.R. on Aug. 29 discontinued the use of Pennsylvania Station, New York City, and began using the Jersey City terminal of the Central R.R. of New Jersey, some means of getting passengers to and from Manhattan other than use of existing means of transportation was deemed advisable. Accordingly motor coach service from two stations—Pershing Square and the Waldorf-Astoria Hotel—was established direct to the station platform.

The central two of four tracks which the B. & O. uses have been floored over for the entire station platform length. Buses are routed over both the 23rd St. and Liberty St. ferries and run out onto this runway to discharge passengers at the train side. To turn the buses around a turntable has been built in the terminal yards a short distance beyond the end of the runway near the frog of the turnout which brings two stub terminal tracks together.

The turntable pictured herewith is built up of two 12-in. I-beams set about 8 ft. apart with their ends connected by short channel irons. This frame supports a floor system of 2 x 12s laid flush on 6 x 8-in. timbers. Three 10-in. solid flangeless cast-iron wheels are set at each end of the steel frame of the table, two at each end being outriggered at the frame corners. Each of the other two wheels is centered between the outriggered wheels. The table turns on a pivot pin set in a mass concrete block and the wheels run on a light rail.

The table is hand turned by the attendant riding each bus, and furnishes a simple and effective means of turning a bus where trackage space is at a premium.



BUS TURNTABLE USED BY B. & O. RY. AT JERSEY CITY

From Job and Office

HINTS THAT CUT COST AND TIME

Box on Ford Running Board Carries Survey Party Equipment

BY ALDEN WELLS
Hartford, Conn.

THE accompanying picture shows a box mounted on the left running board of a Ford to carry the bulky baggage of a survey party. The lower part of the box, entered by a drop door in the side, holds a supply of stakes, a hammer, a bull point and the like. The upper compartment is longer than the stake box, extending

HOW HARTFORD SURVEY PARTY CARRIES EQUIPMENT

From Job and Office

FOR CONTRACTOR AND ENGINEER

out at both ends over the wheels of the car. This is open at the rear end and carries an assortment of rods. This section is divided and lined with pieces of discarded fire hose in such a way that the rods do not rattle on each other or the box, nor do they become scratched. The ends of the rods are protected from the weather and injury from other sources by an overhanging end of the top of the box and can safely be kept on the car throughout the season. Two notched blocks on top form a rack into which the tripod fits easily and securely. The transit is unscrewed and carried on the seat with the driver. Tapes, plumb-bobs and small tools are kept in a Boston bag inside the car.

The car pictured is one of a fleet so equipped in use by the city engineer's office at Hartford.

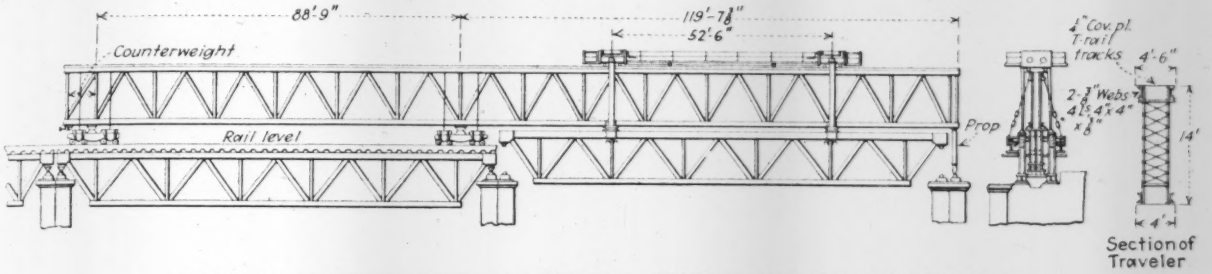
Deck Trusses in India Erected by Unusual Traveler

RECENTLY it was necessary to double-track the Upper Sone bridge, in India, a structure consisting of a long series of 100-ft. deck truss spans on masonry piers. The work was done by the rather unusual method of carrying the fully assembled trusses from the storage yard at one end of the bridge to their place in the structure by a cantilever traveler with 119-ft. overhang and lowering them to place on the bridge seat by trolley hoists on the same traveler.

The traveler was carried by two trucks spaced 88 ft. 9 in. apart, and had a forward overhang of 119 ft. 7⅞ in. It consisted of a single set of chords and web members, cover plated or latticed to a spread of 48 to 54 in. over all. On the top chord were mounted two trolleys connected to form a two-hoist traveling crane, the trolleys being 52 ft. apart longitudinally and each having a set of falls on either side of the traveler girder. With this arrangement, the traveler carried two of the 100-ft. bridge trusses during a single trip, one suspended on either side of the traveler.

While moving out from the yard, the crane carried the two girders suspended alongside its rear portion. It was moved out by a locomotive, until its forward truck was near the outer end of the last span erected and the overhanging end was over the pier next ahead. A jacking strut attached to the nose of the traveler was then set on the farther of the two shoes on the pier, as the sketch shows, and the end of the traveler jacked up about 6 in. to take out its deflection. Then the traveler trucks were blocked up, and the crane carrying the two bridge trusses was moved forward on the top chord until they were directly over their bearings, when the falls lowered them to seat. Thereupon the jacking strut again lowered the nose of the traveler, freeing it and leaving it ready to move back to the yard. The jacking strut was left in place on the pier ready to be picked up by the traveler on its next trip out.

In a description of the traveler in *Engineering* of April 2, p. 417, the weight of the traveler is given as 68 tons (of 2,000 lb.), counterweight 10½ tons, traveler crane 22.6 tons. The weight of two of the 100-ft. deck trusses is 78½ tons. The structure was designed for these loads and for a 20-lb. wind pressure, at a working stress of 22,400 lb. per sq.in.



SKETCH OF TRAVELER USED IN DOUBLE-TRACKING UPPER SONE BRIDGE, INDIA

Job and Office Notes

To Provide a Safeguard Against Accidents in loading holes with dynamite, two employees of the Webber mine of the Commerce Mining & Royalty Co. have developed a primer container. This device consists of a tough cardboard tube of an inside diameter to accommodate the size of cartridge in use with a wooden plug 2½ in. long fastened in one end. Through this plug runs a diagonal hole just large enough to permit the safety fuse to slide through it easily. In the center of the plug is a dead-end hole 1¾ in. deep and ⅜ in. in diameter to accommodate the standard length of spike on the tamping bar, which is 1½ in. long and ⅛ in. in diameter. A foot or so of the fuse is first drawn through the diagonal hole in the plug and a blasting cap is then crimped onto the fuse and inserted in the dynamite cartridge. The primed cartridge is then drawn back into the cardboard tube. As the hole for the fuse is a neat fit, the fuse itself will slide through the plug but the crimping on the blasting cap prevents it from being pulled through this hole. Finally the end of the tube is crimped over the end of the cartridge and the incased primer is placed on the spike of the tamping bar and pushed back in the usual manner. The use of this safety container, according to the "Explosives Service Bulletin" issued by Du Pont, should eliminate the hazard that is ever present when loading unprotected primers and bore holes in broken irregular rock.

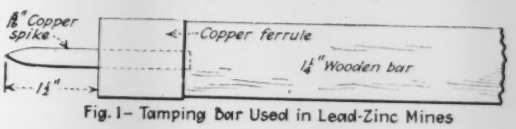


Fig. 1 – Tamping Bar Used in Lead-Zinc Mines

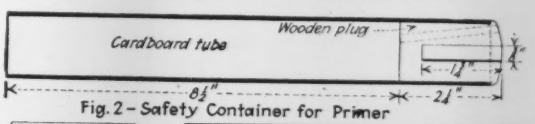


Fig. 2 – Safety Container for Primer

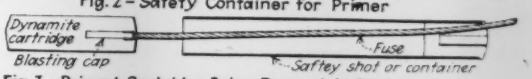


Fig. 3 – Primed Cartridge Being Drawn into Place in Safety Container

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

The New York Barge Canal Again

Sir—In your issue of Sept. 9, 1926, p. 429, you have an article by Morris W. Williams, engineer formerly connected with the New York Barge Canal, also an editorial article on the same subject.

The writer was appointed to the board of consulting engineers of the New York Barge Canal in 1915 at which time the canal was practically completed but needed some modification and changes to put it in working order. This was done and the canal put in operation, if I remember correctly, about a year or so after.

A great deal of discussion has been had since that time as to the utility of the canal and the question has been raised a number of times as to whether it should be abandoned by the state; in fact, legislative investigation was recently made for the purpose of answering this very question.

It seems to me that all these discussions and investigations overlook the principal point in connection with the use of the barge canal. If I remember correctly, the old Erie Canal had a depth of 7 ft. of water, and an appropriation was made, of $9,000,000 for the purpose of increasing the depth 2 ft. more, making a total of 9 ft. This modification was opposed and the barge canal authorized which was to give a clear depth of 12 ft. of water throughout, a width of locks of 45 ft., with length sufficient to permit the passage of 2,000-ton barges at a time, of about 310 ft. In the actual construction of the canal a clear depth of only 9 ft. was secured. The locks had a clear depth of 12 ft. over their sills. Their width, however, was several inches inside of the specification in a great many cases.

I understand that the recent engineering reports show the canal at the present time to have a clear depth of only 7 ft. in places.

It was contemplated that steel barges with a carrying capacity of 2,000 tons would be built and used in the canal. It was expected that these barges would go in fleets of four, there being power in the first barge sufficient to handle itself and the other three. It was believed that these barges could be made sufficiently seaworthy so that they could travel on the Great Lakes in safety and bring their cargoes from Detroit or any of the other western ports without being broken up at Buffalo, but carried directly to New York. If the canal had been properly constructed to admit of this operation the question of its earning power and utility would be an entirely different one from what it is today.

You can readily understand that capitalists must be unwilling at the present time to make large investments in barges for transportation which will immediately become useless if the canal should ever be completed to its proper depth, and it would seem to me that the only question worthy of consideration at the present time is the completion of a barge canal along lines of the original plan or whether it should be abandoned entirely as a means of transportation.

There is another important feature in the barge canal, and that is its water power. There is no doubt that the old Erie canal was one of the main elements in making New York the empire state through its transportation, and the power that was derived from the falls after various locks. Many important towns and cities have been built up at these points and have become leading manufacturing centers of the country. When the barge canal was constructed these water powers were all augmented many times by new and scientific installations producing many times the amount of power that was originally developed, and this increased power is used throughout the canal with profit and benefit. I do not refer to the independent dams like Vischers Ferry, Cohoes, and other places where the state has developed the power on its own resources and is selling it in the various communities where they are located.

For the reasons stated, it seems useless to try to enter into any discussion of the financial aspect as the canal now stands.

ERNEST C. MOORE,
Chief Engineer, Delray Ocean Estates, Inc.
West Palm Beach, Fla.,
Sept. 30, 1926.

[With reference to Mr. Moore's statement concerning the present depth of the canal: The report of the Barge Canal Survey Commission, made to the New York State Legislature in February of this year, states "While the canal was designed to accommodate boats of 10-ft. draft, barges loaded to 10 ft. 6 in. have successfully navigated the canal during the season of 1925." The commission recommended that in order to maintain a 12-ft. depth the canal be dredged to a depth of 15 ft. In 1924, the state engineer recommended to the Legislature that wherever silting of the canal prism is taking place, that it be dredged to a depth of 14 ft. Considerable dredging on this basis was done in 1925 and more is being done this year.

In the matter of the width of the canal locks, it should be stated that the controlling width is that of the U. S. Government lock in the dam across the Hudson River at Troy, which is 44.44 ft.—EDITOR.]

Do Baffle Piers Dispel Energy?

Sir—In an article headed "Baffle Piers at Toe of Dam Dispel Energy of Flow," in the June 3, 1926, issue of *Engineering News-Record*, I. C. Steele, chief of Division of Civil Engineering, Department of Engineering, Pacific Gas & Electric Co., described some experiments on models of the diversion dam for Pit No. 3 power development of the Pacific Gas & Electric Co. The data from these experiments are presented in such manner that the inference may be drawn that baffle piers, rather than the formation of the hydraulic jump, are to be credited with dispelling the energy of the flow at the toes of his models. Unfortunately Mr. Steele gave no data with respect to the depths required to develop the jump without the baffles so the reader is not able to make his own comparisons.

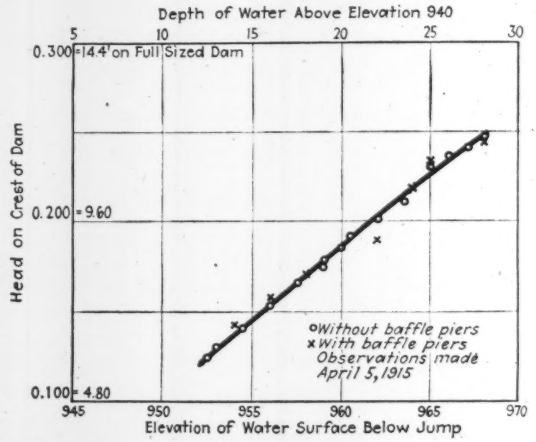


FIG. 1—DEPTHS OF WATER REQUIRED TO BRING JUMP TO TOE OF DAM

Results with and without baffle piers. Plotted from observations on a straight model dam.

Mr. Steele's experiments recall a series along the same lines made by the writer in 1915 on models of Cheoah dam on Little Tennessee River, for which plans were being prepared at that time and which was placed under construction in 1916. In these experiments determinations were made of the depths of water required to bring the jump to a definite position at the toe of the dam for specified depths of flow over the crest, without and with such baffles in place. The resulting data are shown on the attached curve, Fig. 1. The points obtained without the baffle piers in place plot very closely to a definite line. The exact location of the jump with the baffle piers in place was a rather difficult matter to place definitely and could only be accomplished by building up the pool level and observing the movement of the beginning of the jump

toward the dam, estimating as closely as possible its probable position when reaching the disturbance caused by the piers. Naturally these points deviate materially from any definite curve, but as they seem to lie indifferently above and below the curve obtained without the baffles in place, it appeared to us that the amount of energy actually absorbed by the piers was negligible and whatever absorption of energy occurred was ascribable 99 per cent or more to the action of the jump "pure and simple."

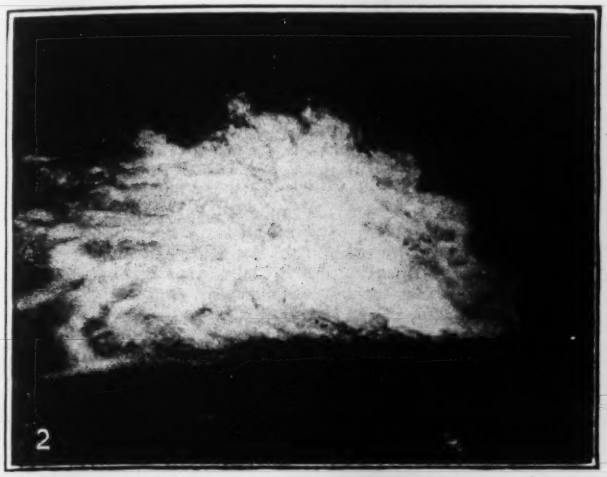
In addition to the original curve, I am sending two pictures taken for identical depths of water on the crest and in the channel below the dam, one, Fig. 2, without the baffles and the other, Fig. 3, with the baffles in place. The baffles probably smoothed out the surface flow but certainly had only a very minor part in the actual absorption of energy. The character of the baffles is shown in a third picture, Fig. 4. What does happen when the depth of water in the channel is not sufficient to develop the jump is vividly portrayed by Fig. 5, a picture of Gatun Spillway on Panama Canal. Similar action took place in the models tested by the writer when the depth of water in the channel was not sufficient to develop the jump and I infer the same action took place in Mr. Steele's models, as he mentions the fact that the water hurdled the piers in many cases.

The minimum depths actually required to develop the jump were determined in all cases and in the same manner so that the results are directly comparable. Pictures were taken for the entire series shown in the curve and the accompanying pictures are presented only as being typical.

ROBERT F. EWALD,
Assistant Engineer, The Aluminum Company of America.
Pittsburgh, Pa., Sept. 16, 1926.

Sir—Robert F. Ewald's comments concerning my article on "Baffle Piers at Toe of Dam Dispel Energy of Flow" are very interesting and of value. However, I cannot agree that whatever absorption of energy occurred was ascribable 99 per cent or more to the action of the jump. Just what this percentage might be is of course very difficult to determine but from observations made I am personally satisfied that a very considerable portion of the energy was actually absorbed by the piers and by the action of the various bodies of water against each other. After all, the primary purpose of any form of stilling device is to force and confine the hydraulic jump within given bounds and to dispel the energy as much, and with as little disturbance as possible, within these bounds either with the hydraulic jump or a combination of the hydraulic jump with other mechanical means.

The location, size, type and shape of baffles used by Mr. Ewald on models of the Cheoah dam on the Little Tennessee River in 1915 are so much different from those used in the experimental work for the Pit No. 3 dam that there can be no justification for a comparison of results obtained, although each set of experiments in itself is of value. It is



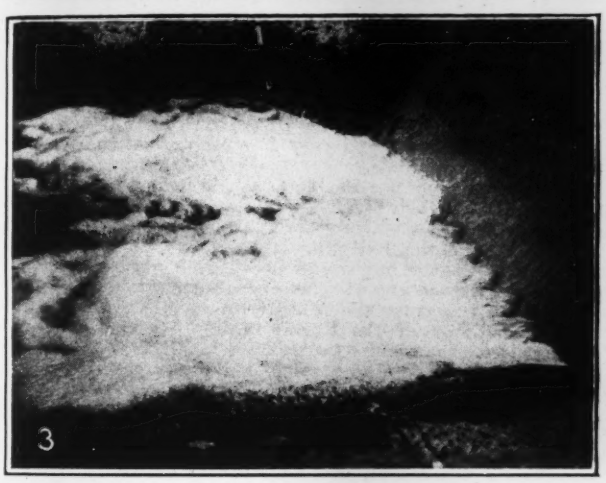


FIG. 2—TEST DAM WITH BAFFLE PIERS OUT
Corresponds to 40,000 sec.-ft. over dam. Head on crest 11.9 ft. Water surface in channel 968.5 ft.

FIG. 3—TEST DAM WITH BAFFLE PIERS IN PLACE
Same head on crest and water surface elevation in channel as in Fig. 2.

FIG. 4—TYPES OF BAFFLE PIERS USED IN TEST
Piers placed in two rows, the first row staggering the openings between piers in second row.

FIG. 5—GATUN SPILLWAY, PANAMA CANAL
One gate partly open. Showing what happens when sufficient depth of water is not available to develop hydraulic jump.

believed, in the case of Pit No. 3 experiments, that three particular factors apparently not tried in Mr. Ewald's experiments were largely responsible for the excellent results obtained with the baffle piers used. These were:

(1) The 15-ft. vertical bucket jump-off.
(2) The use of baffle piers with curved upstream faces.
(3) Comparatively wide spacing of piers.

The baffle piers approximate the shape of the bucket on an impulse wheel and there can be no doubt that this form of deflector must absorb a considerable amount of energy. In addition the water which is directed against the upstream faces of these baffles must necessarily be changed in direction to such an extent as to cause strong cross currents which again must dispel energy. The baffles as portrayed in the picture of the Gatun spillway in the Panama Canal have flat, practically vertical upstream faces and act more in the nature of two low, broken wall obstructions, and it is to be noted that the spillwater leaves the toe of the dam horizontally. It is believed that the latter feature might readily cause the hurdling effect mentioned by Mr. Ewald.

I wish to recall attention to the fact, as stated in my original article, that even though some form of stilling pool might have proved a better means of dispelling the energy and creating a hydraulic jump, within reasonable bounds (which I doubt), this was deemed inadvisable in connection with the plan for our Pit No. 3 dam.

I. C. STEELE,
Chief of Division of Civil Engineering,
Department of Engineering,
Pacific Gas and Electric Co.

San Francisco, Calif.,
Oct. 28, 1926.

Still an Open Question

Sir—The editorial note, "Open to Question," in your issue of Sept. 9, p. 401, has a very familiar ring and is quite consistent with the stand taken and supported by you for some time. After a careful reading of the note I think the question is still an open one.

It is probably true that there has been a tendency on the part of some state health departments to seize the opportunity, when approval of extensions of sewer systems was requested, to attach a rider providing that approval of plans was granted subject to installation of sewage-works within a certain time limit, but not in every case was this a punitive method of accomplishing their objective.

It is quite a nice question just what latitude should be permitted a state executive or board in passing on a request of this kind. If discretion in interpreting the law is exercised he is criticised for assuming too much authority, while if a strict interpretation is adhered to then he is deficient in administrative qualities and judgment. Where overflowing cesspools from congested buildings or population or where character of soil menaces public health, my experience is that approval was never withheld, though persuasive, not big stick methods, might be employed to get a satisfactory method of final disposal.

A literal interpretation of many state laws permits the executive no alternative in withholding approval until some satisfactory method of treatment is provided. State health authorities have their weaknesses, just as other individuals, but if autocracy were predominant I have never known one to get very far with it. Quite to the contrary, they many times have to stultify themselves in order to hold their jobs.

I doubt if facts will show that any state health departments have concentrated on sewage disposal to the neglect of more vital health measures, such as water supplies. Indeed my experience has been that considerably more concentration on sewage disposal would have been very helpful. The appropriations allotted to the engineering bureaus of state health departments, with one or two exceptions, have been far from commensurable with the work they were requested to do. If any one phase has been given more attention than another, in my opinion it has been that of water supplies and even here state health authorities have been severely handicapped by the confusion as to whether their jurisdiction was confined to purity of the supply or included adequacy and proper design—divisions which I think it will be generally admitted are closely related. Many water companies prefer to submit questions of adequacy and design to the review of the public utilities commission and in the matter of sewerage there has not formerly been such divided responsibility, though the tendency now is to separate this also and place all except that directly pertaining to health under separate commissions.

If there is any criticism it seems to me it should be of the laws themselves and not of those who have to administer them. With the limited means at their disposal I believe the administrators have been impartial and that they have been very successful in solving the increasing number of sanitary problems which have come up in the past decade.

J. FREDERICK JACKSON,
Consulting Engineer;
formerly Engineer, Connecticut Department of Health.

New Haven, Conn.,
Sept. 14, 1926.

Differing Views on Use of Water Supply Reservoirs for Recreation

Sir—I am very much interested in reading the successful exploitation for recreation purposes of the reservoirs in the San Diego watershed, as described in your issue of Sept. 2, p. 386. The plan of operations could not be better conducted or in better hands than those of Mr. Wueste, who is an extremely careful man, but I believe every sanitary engineer in the United States, with a knowledge of water-supply problems, would disapprove of the general use of reservoirs for hunting, fishing and recreation purposes.

San Diego was launched into the water business by E. S. Babcock, who was quite an original character and a western pioneer of fine constructive ability. He practically built the Upper Otay dam, in the shape of a very thin arch only 4 ft. thick at the top, 80 ft. in height, with a radius of 359 ft. One of his favorite diversions on the lake above the Upper Otay was to reserve for himself and his friends the hunting and fishing privileges, on which he exercised a monopoly until his death a few years ago. I am informed, and photographs confirm the information, that one of the favorite pastimes was to have a hunting rodeo with a line of boats across the lake and advance in military formation against the ducks and slaughter them on the lake. This of course meant the diffusion of blood and was rather a barbarous practice on a domestic water supply reservoir.

When J. D. Spreckels succeeded to the administration of the property and the Lower Otay was devoted to the use of drinking water for San Diego, strict sanitary restrictions were imposed and very few people had the privilege of fishing in the lake.

Other cities on the Pacific Coast do not gamble with the integrity of their watersheds by allowing trespassers. Portland, Ore., positively forbids any travel above its intake dam on the Bull Run River about 30 miles east of the city. Seattle has the exclusive ownership of its Cedar River watershed and does not encourage trespassers.

Due to the great vision of Hermann Schussler, the late chief engineer of the Spring Valley Water Co. of San Francisco, that company's 51,560 acres of land was held in fee to protect the area surrounding the three reservoirs of Pilarcitos, San Andreas and Crystal Springs, on which no trespass is allowed. I believe it was a wise expenditure on behalf of the company, which the city will inherit when it acquires the property under option at an early date.

It is a well-known fact that one typhoid carrier would distribute the disease amongst thousands, and why any community should indulge in the practice of commercial exploitation of its watersheds, and thereby risk the health of its inhabitants, is beyond me.

I trust the unique scheme suggested by Mr. Wueste for the utilization of the San Diego watersheds will not furnish an exhibit for any other of our modern American cities.

M. M. O'SHAUGHNESSY,
City Engineer.

San Francisco, Calif.,
Sept. 25, 1926.

Tunnels Floated into Place

Sir—Your editorial reference to the method of building tunnels by floating tubes into position and then sinking them, in *Engineering News-Record* of Oct. 28, 1926, p. 689, omits one interesting example of this practice. The river section of the LaSalle St. tunnel for the Chicago street railways consists of a double-track double-tube steel shell 280 ft. long, which was built in a dry dock, floated into place, sunk between bulkheaded approaches and then concreted. This work was described in detail in *Engineering News* of Jan. 12, April 13, Aug. 10 and Sept. 21, 1911, pp. 52, 461, 172, and 330 respectively.

TUNNELS.

Chicago, Ill.,
Oct. 30, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

McCarl Rules on Federal Aid and Toll Bridges

Controller Finds No Aid Can Be Given Road Serving Mainly as a Toll Bridge Approach

J. R. McCarl, controller general of the United States, has just rendered an opinion to the Secretary of Agriculture on the legal status of federal aid for roads in the vicinity of toll bridges. His interpretation of the federal-aid law declares that no aid can be given to any road whose main function is to serve as approach to a toll bridge. This finding covers all classes of toll bridges, including those in existence before the passage of the federal aid law, those constructed afterward, and those built under special congressional acts. The Secretary states that the department had made a distinction between the two classes, holding that in general bridges or ferries established since the passage of the federal aid law should not be benefited by federal aid on their approaches, since the law states that all highways built under the act "shall be free from tolls of all kinds." With respect to this distinction, he says:

"Some projects have been approved for improvement with federal aid of highways leading to toll ferries or bridges which were in existence at the time the federal aid highway legislation was enacted, but in these cases, generally, such approval has been subject to the condition that the toll ferry or bridge would be made free within such stipulated period as was determined would be feasible and practicable in each case for arrangement to be made for freeing the crossing of tolls. In like manner, some projects have been approved for improving with federal aid highways leading to toll ferries or bridges constructed or established subsequent to the passage of the federal aid legislation, but only in cases where definite provision was made for the removal of the toll charges within a specified time, often before the final payment of federal funds on the project would be made."

Specific Case Cited

A specific case is then cited, for two sections of road, one east and one west of the Atchafalaya River, respectively 5 and 7½ miles long, for whose construction federal aid in the amount of $147,000 was asked; the Atchafayala River bridge connecting the two sections of road was to be a toll bridge, being part of the railroad bridge of the N. O. T. & M. R.R.; the tolls were to be so adjusted as to cover the carrying cost on the highway part of the bridge, but the agreement for highway use might be abrogated entirely after ten years.

Controller McCarl's decision looks aside from any specific features of the Atchafalaya River case and declares the no-toll provision of the Federal Aid Acts to be complete, comprehensive and mandatory, and to serve as a bar to the use of federal aid for construction of any road that may be held to constitute an approach to a toll bridge. He says "federal aid should not be given for the construction of any portion of the highway on either side of the bridge or ferry back to a point up to which a reasonable use would be made of the highway other than as a means of approach to the bridge or ferry, such as intersecting highway giving a choice of direction to a town, village, etc." He holds that the statute warrants no exception being made in favor of toll bridges or ferries constructed and in operation prior to the passage of federal aid laws. He finds also that a congressional franchise does not affect the matter. "Full force and effect can be given to the act authorizing the construction and operation of the toll bridges without using federal funds to aid in the construction of the approaches to said bridges."

Summarizing these findings, the controller declares that no future payment on projects on which no work has been started, whether heretofore or hereafter approved, which include approaches to toll bridges or ferries contrary to the views expressed in the decision should be made, unless and until specifically authorized by law. He also advises the Secretary that federal aid funds cannot be used for the sections of road leading up to the Atchafalaya River crossing, so far as they constitute approaches to the bridge.

Engineering Fifty Years Ago

From *Engineering News*, November, 1876

DURING the month of the Centennial the Pennsylvania Railroad Co. started 22,917 trains from Jersey City alone, westward, made up of 127,080 cars, carrying not less than 7,500,000 passengers. This includes no way passengers, and only the travel in one direction.

Tolls on Camden Bridge Average $200,000 Monthly

Four months' operation of the Philadelphia-Camden bridge over the Delaware River has resulted (July 2-Nov. 1) in toll collections of $806,427. The monthly figures were $226,485, $219,518, $177,097, and $183,326. About three-fourths of the income has been from private passenger automobiles, at a toll rate of 25c., while the remainder is truck and passenger bus traffic.

Pontchartrain Bridge Cause of Highway Controversy

Bureau of Public Roads Takes Hand in Mississippi-Louisiana Road Problem

Protest filed by the Mississippi Highway Commission has led the Bureau of Public Roads to ask the Louisiana Commission about its plans for "expediting the construction of the bridges and the improvement of the highway between Slidell and New Orleans so as to accommodate traffic with free and expeditious passage thereover."

Mississippi's protest was prompted by the completion of plans for the construction of a privately-owned toll bridge over Lake Pontchartrain. It was contended on behalf of Mississippi that great effort, including the construction of expensive bridges, had been expended to carry the Spanish trail highway to the Louisiana line, only to be confronted with the toll bridge which, it was feared, had been substituted for the federal aid link of the Spanish trail highway.

This led the Bureau of Roads to call the attention of the Louisiana Commission to the fact that it has the power to "withhold federal aid on other projects in the state in order to secure the submission and improvement of projects necessary to expedite completion of an interstate route such as the one here involved."

An advisory committee of engineers has recommended to the mayor of New Orleans that the bridges on the federal-aid route be constructed. This route skirts the lower end of Pontchartrain, whereas the privately-owned bridge runs directly across the lake from Slidell. The mayor's engineering committee estimates that Chef Menteur, the Rigolets and Salt Bayou can be bridged and concrete trestle approaches and storm protection provided for a sum somewhat less than $3,000,000.

The toll bridge has been the subject of a bitter political controversy. It had the support of the state administration which changed unexpectedly with the death of Governor Fuqua.

Large Hydro Plant to Be Built on Savannah River

The Savannah River Electric Co., a subsidiary of the Southeastern Power Co., has applied to the Federal Power Commission for authority to construct a hydro-electric power plant on the Savannah River on the Georgia-South Carolina line near Clark's Hill, 21 miles above Augusta, Ga. The plant is expected to have an installed capacity of 120,000 hp. and to cost in the neighborhood of $20,000,000.

Preliminary plans call for a dam 90 ft. high and 3,800 ft. long with an 800-ft. spillway. The pond will have an area of 35,000 acres.

Wisconsin Offers Lectures on Engineering Economics

In co-operation with the University of Wisconsin, the Engineers Society of Milwaukee, with its affiliated societies, has arranged for a course of twelve lectures on engineering economics, as listed below. These lectures will be given at the Milwaukee public library and a charge of $10 will be made for the entire course: Nov. 12, "Economic Aspects of Engineering," F. E. Turneaure; Nov. 19, "Economics of Water Power Development," D. W. Mead; Nov. 26, "Fundamental Principles of Railroad Rates," H. R. Trumbower; Dec. 2, "Labor Management," D. D. Descohier; Dec. 9, "The Place of Cost Accounting in Industry," F. H. Elwell; Dec. 17, "Economic Aspects of Steam Engineering," G. L. Larson; Jan. 8, "The Financing of Modern Corporations," S. W. Gilman; Jan. 15, "Use of Statistics in Manufacturing," H. Jerome; Jan. 22, "Economics of Gaseous Fuel," O. L. Kowalke; Jan. 29, "Control and Regulation of Public Utilities," M. G. Glaeser; Feb. 2, "The Engineer's Interest in Advertising," E. H. Gardner; Feb. 10, 'Economics of Natural Resources," C. K. Leith.

Chicago Holds Conference on Education and Industry

The outlook for certain important industries was the main point of a series of addresses made at the third public conference on education and industry, held at the University of Chicago on Oct. 27. As to the building industry, Ernest R. Graham, architect, noted the co-operative work of city planning and the tendency to higher architectural treatment and the provision of modern conveniences. In particular he pointed out that almost invariably such city structures as railway stations, banks and commercial buildings prove to be of inadequate size, owing to the rapid growth of the country and its activities.

Other papers included "The Oil Industries," by W. S. Farish, president of the American Petroleum Institute; "The Automobile Industries"; by Edwin S. Jordan, president of the Jordan Motor Car Co.; "Finance," by Dwight W. Morrow, of J. P. Morgan & Co., and "Transportation," by Fred W. Sargent, president of the Chicago & Northwestern Ry. The meeting was presided over by Max Mason, president of the University of Chicago.

Detroit Rejects Stone Curb Bill

A proposed charter amendment which would have made imperative the use of natural stone curbing cut in the city, in connection with paving construction in Detroit was defeated by the voters on Nov. 2. The initiatory measure was put on the ballot only after the necessary signatures to the petition had been obtained. The measure was sponsored by the Detroit members of the American Federation of Labor, and was vigorously opposed by the officials of the Department of Public Works. At the present time either stone or concrete curbing may be used.

Fifty Years From Bridge to Bridge

IN THE *Engineering News-Record*, Oct. 14, p. 639, there was printed a brief item from *Engineering News* of Oct. 14, 1876, reporting that the stone work of the new Monongahela River bridge at the Point, in Pittsburgh, had just been completed, at a cost of nearly $200,000. Norman S. Brown, director of the Department of Public Works of Allegheny County, now writes that the masonry of the new Point bridge has just been completed by the Dravo Contracting Co., of Pittsburgh, at a cost of about $657,000. Steel erection has been going on since early summer, beginning on the north side, where the masonry was first completed, and at the present time most of the steelwork is in place. The Fort Pitt Bridge Works, also of Pittsburgh, is fabricating and erecting the superstructure. Present expectations are that the erection of the steel will be completed by January, 1927, and that the bridge will be open to traffic early next year, Mr. Brown says.

The old bridge was a truss stiffened, chain suspension bridge, noteworthy for decades as the only one of its kind in the country. The new structure is a three-span cantilever, with central span of archlike outline rising high above the roadway. This form was adopted at the suggestion of the members of the Art Commission, to harmonize with the convex outline of the Allegheny River Point bridge, nearby, which consists of two simple truss spans of about 500 ft.

Two State-Owned Water and Power System Measures Defeated

Voters of both Oregon and California defeated at the election of Nov. 2 proposed constitutional amendments to create boards and appropriate money for the development of water and power resources by the state. The California measure is practically the same as that one which first appeared on the ballot several years ago, the 1926 measure representing the third attempt at state-owned and operated water and power developments. The 1926 bill, as its predecessors, proposed the bonding of the state in the sum of $500,000,000. This bill was defeated by a 2½ to 1 vote.

The Oregon bill, defeated by about 3 to 1, proposed creation of a board of five elective members with full authority for the conservation, development, storage and distribution of electric energy and water for irrigation and domestic uses. It proposed issuance of bonds not to exceed a sum equal to 5 per cent of the state valuation, estimated at the present time to be in excess of $50,000,000. This bill was initiated by the Houswives Council, Inc.

Los Angeles Flood Control Bond Issue Defeated

The proposed $26,000,000 bond issue for further work by the Los Angeles County Flood Control District was defeated at the election on Nov. 2. This issue was to supplement the work initiated two years ago when an issue of $35,300,000 was approved. The $26,000,000 issue was opposed, among other organizations, by the Los Angeles City Committee of the California Taxpayers Association, and the Los Angeles Chapter of the American Association of Engineers.

Missouri Pacific Extension in Arkansas Authorized

The Interstate Commerce Commission has just authorized the Missouri Pacific R.R. to construct an extension of its Hot Springs branch in Garland County, Ark., 11.82 miles. The main purpose of the proposed extension is to serve a lumber mill which the Dierks Lumber & Coal Co. is building at the northwestern terminus of the proposed line. The extension is intended for freight and switching service only. The lumber company owns a large acreage of virgin yellow pine timber, estimated to yield 1,000,000,000 ft. of lumber, which the new line will tap.

The estimated cost of construction of the line is $395,000. The applicant plans to finance the initial construction cost from current funds and to reimburse its treasury upon completion of the extension by issuing bonds under its first and refunding mortgage. It is expected construction will begin Jan. 1, 1927, and be completed in seven months.

California Water Works Men Meet at San Diego

At the seventh annual convention of the California Section, American Water Works Association, held at San Diego Oct. 28, 29 and 30, more than 400 were in attendance, by far the largest convention yet held by this section. An indication of the representative attendance was the registration of water works men from Vancouver, B. C.; Tucson, Ariz.; Salt Lake, Utah, and Denver, Colo., as well as delegates from a very considerable percentage of California cities.

The convention was held in American Legion Hall in Balboa Park where there was available a 46x110-ft. meeting room adjoining a 77x110-ft. hall which was fitted up with booths for the manufacturers' exhibits. In all, fifty exhibitors had displays, completely occupying all available space in the hall. There was on display a practically complete line of materials and equipment essential to construction and operation of the modern water-supply system.

Officers elected for the ensuing year were as follows: Chairman, S. B. Morris, Pasadena; vice-chairman, J. J. Ryland, San Jose; secretary-treasurer, Paul Magerstadt, Oakland; membership committee, P. Dietrich, Glendale, and J. Burt, San Rafael. The annual meeting next year will be at San José.

Public Works Bond Issues Approved Nov. 2

Detroit Votes $30,000,000 for Water Extensions—Chicago to Spend $15,000,000 on Streets

An issue of $30,000,000 of public utility bonds for extensions to the city water system in Detroit was approved by a large majority of the voters of the city at the election Nov. 2. It was pointed out by city officials that the issuance of these bonds will not increase city taxes inasmuch as the water department is self-sustaining and the bonds will be retired by a sinking fund created from the water rates and can be taken care of without any increase in water rates.

Chicago and Cook County approved a bond issue on Nov. 2 of $15,000,000 for widening and improving the county roads leading into Chicago. This program of widening and paving to a width of 40 ft. will be begun promptly and it is expected some thoroughfares will be completed by next summer. This program is said to cover some 535 miles of existing and proposed roads.

Dayton Approves Large Issue

Dayton, Ohio passed issues totaling approximately $9,000,000. Of this sum $8,000,000 is to be appropriated for grade crossing elimination work, the other $1,000,000 to be spent—for street and sewer construction $450,000; for fire department signal service, $400,000; and for extending and opening streets $100,000. Miamisburg, Ohio, passed an issue of $150,000 for a new school building.

Numerous small bond issues were carried by Columbus and by Franklin County outside of Columbus. Columbus approved bonds to construct four new schools and additions for a total expenditure of $205,000. Three Franklin County townships approved issues totaling $380,000.

Duluth, Minn., approved an issue of $500,000, the most of which will be spent on new public buildings and park improvements.

Akron, Ohio, had two $500,000 proposed issues for street and sidewalk construction and widening but defeated both of them. However, townships in Summit County passed issues approximating $1,210,000 mainly for school buildings. The county in which Lorain, Ohio, is situated, approved the issuance of $2,199,000 for the construction of a bridge over the Black River as an important link in the road between Lorain and Cleveland.

Harrisburg, Pa., passed by a considerable majority, a bond issue of $1,274,000 to be divided among grade crossing elimination, sewerage extensions, paving and subway widening.

In other cities of Pennsylvania issues were approved as follows: Altoona, $2,000,000 for schools; Hollidaysburg, $100,000 for a new school; Johnstown, $800,000 for bridges, sanitary sewers and paving; and Steelton, $250,000 for schools.

Bonds in the sum of $1,350,000 were authorized by Kansas City for the construction of a free bridge across the Missouri River connecting Kansas City and Clay County. Preliminary data on this project were carried in these columns several weeks ago.

In Portland, Ore., proposed bond issues of $6,750,000 to build a bridge across the Willamette River at Interstate Ave. and another $4,000,000 issue for providing a Willamette River bridge at St. Johns, both were defeated. A bond issue of $750,000 for repairs to the existing Broadway bridge, including a plan for additional ramp approaches, carried.

In Los Angeles, city and county, eight proposed bond issues totaling $48,500,000 were all defeated. The defeated measures included $26,000,000 for county flood control projects, $5,000,000 for grade separation, $5,000,000 for a civic center and $200,000 for garbage-loading stations. The defeat of these bond issues is ascribed in part to William Mulholland's recent warning against approaching the bond limit now because the Colorado River water project would soon need funds.

In Tacoma, Wash., an issue of $750,000 for the improvement of tidal flats was defeated.

The state of California approved an issue of $6,000,000 to be divided equally between the University of California and the University of Southern California for new buildings. Another state issue voted upon favorably was $2,500,000 for state buildings to be erected at Los Angeles and Sacramento.

Stanislaus County defeated two proposed issues, one of $800,000 for a new court house and one of $287,500 for an American Legion Memorial Hall.

In the city of San Jose six proposed bond issues were defeated. These were as follows: municipal auditorium $750,000; fire-alarm system $75,000; bridges, $275,000; and three for Alum Rock Park improvements $175,000.

Toledo to Spend Millions

The citizens of Toledo, Ohio voted favorably on a proposition to divert one mill for the city's portion of street paving costs for a period of five years. This will mean a program for street improvements of about $3,000,000 yearly over that period. Bond issues which Toledo passed included one of $300,000 to house police and fire-alarm apparatus, $90,000 for police and fire-alarm extensions, $500,000 for widening and extending streets, $2,000,000 for intercepting sewers and $2,500,000 for sewage disposal. Another millage bill passed by Toledo and Lucas County will raise approximately $800,000 per year for five years for county road work.

Five Wisconsin counties, Waushara, Langlade, Chippewa, Marathon and Fremont approved bond issues for road improvements totaling $6,955,000.

The city of Pontiac, Mich., approved several bond issues at the Nov. 2 election, including the following: water mains and extensions, $330,000; sewers and addition to sewage disposal plant, $390,000; storm-water drains, $330,000; new fire stations, $170,000; garbage-disposal plant, $30,000.

A bond issue of $1,000,000 was approved by the voters of Wayne County, Mich., to finance the construction of a new county jail.

Two New U. S. Reclamation Projects to Be Built

Owyhee, Estimated to Cost $17,715,000 and Vale, to Cost $3,590,000, Approved by President

On favorable recommendation of the Secretary of the Interior, the President has approved of proceeding with the construction of two new federal reclamation projects in Oregon, the Owyhee and Vale projects. In both cases the secretary reported, as required by law, that the project is feasible, is adaptable for actual settlement and farm homes, and will probably return its cost to the Reclamation Fund. Development of detail plans is expected to proceed at once, preparatory to letting of construction contracts.

The Owyhee project comprises about 124,000 irrigable acres, of which 54,000 acres are now settled and improved and are under irrigation by district organizations, though lacking a sufficient water supply. The remainder, or 70,000 acres, is desert land. The Secretary's recommendation does not state whether any public land is included. It states, however, that a board has appraised the unsettled and unimproved land and has fixed an average selling price of $10.20 per acre for the irrigable areas. Contracts have been made with the two districts and with individual land owners requiring that these prices be adhered to in selling land to new settlers. The area lies partly in Oregon and partly in Idaho. It is to be irrigated by storing the flow of the Owyhee River by means of a concrete arch dam 355 ft. high above foundation, 600 ft. long on top, at Hole-in-Ground reservoir site, giving a total storage of 1,000,000 acre-ft., with live storage of 595,000 acre-ft., which is nearly equal to the total annual project requirements. From this reservoir, tunnel and canal of about 100 miles maximum length will distribute the water to the land to be irrigated, the most remote point being in the neighborhood of the town of Weiser, Idaho. The cost of the project is estimated at $17,715,000, of which about $6,000,000 is for storage and diversion and nearly $10,000,000 for main canals. Construction can be completed in five years.

Construction Charges

Construction costs average thus about $160 an acre, varying, however, with the classification of the land. Forty years have been fixed for repayment (without interest), under the amendment to the Reclamation Act passed at the last session of Congress. This means that the average yearly payment on construction charge will be $4 an acre, varying probably between $3 and $6 an acre, depending on class of land. The Secretary reports that in his opinion the settlers will be able to pay and will pay these sums plus operation and maintenance charges, in spite of the fact that the cost is much higher than that of projects like Boise, Minidoka, Strawberry Valley, and North Platte, whose soil and climatic conditions are similar. He believes that improvements in method of development and in agricultural practices, elimination of land specula-

tion, provision for selection of settlers and provision for giving settlers practical advice on crop program will hasten development and increase earnings, so that intensive cultivation of land may be expected. The Secretary also avers that increase in agricultural production in the nation is not keeping pace with increase in population. For these reasons, and because there is urgent need for a larger water supply by the settlers on the 54,000 acres now farmed, he recommends the project for approval. The President has accordingly approved.

Vale project is located along the Malheur River, in Oregon, and will have an area of about 31,000 acres. Construction will cost about $3,590,000, or about $125 an acre average. Water is to be obtained from Warm Springs reservoir of the Warm Springs Irrigation District, part of the district's rights being purchased for the price of $690,000 and part of this sum, in turn, being expended for the construction of drainage for the district, which is now in difficulties from serious seepage. The total storage capacity of the reservoir, when supplemented by crest gates raising the present water level 4 ft., will be 190,000 acre-ft.; shortages in occasional years are anticipated. A diversion weir on the Malheur River, near Namorf station on the Oregon Short Line, is to supply water to a canal which with flumes and siphons continues to Harper and Jamieson, Ore. About 3,000 acres of the area now have an inadequate water supply and are included in the project; some of this area will be served by pumping. Of the total construction cost, $2,500,000 is for the main canal.

VALE'S OPPORTUNITIES

About 15 per cent of the project area is government land, while about 40 per cent is owned by two land companies. The value of the unimproved land has been appraised at $11 per acre, and the Secretary states that "contracts will be made with the land owners for sales to settlers at not to exceed these prices." The climate and soil are said to be suitable for all temperate zone crops and fruit with yields about equal to those of the Boise project. The topography is declared excellent. About half of the land is first class as to productivity, the rest second and third class. Railroad facilities are good. Dry farming has been a failure on the area. "With an ample water supply for irrigation, this area will sustain a highly intensified agriculture and make homes for from 400 to 500 additional families. In addition to this, it will rehabilitate the Warm Springs Irrigation District, having an irrigable area of about 32,000 acres, thus saving the investment already made by many American farmers therein."

On the question of whether the cost of construction will probably be returned to the reclamation fund, the Secretary says that under the contract with the Vale irrigation district, calling for 40 annual payments on construction in accordance with the new reclamation law, it should be possible for the settlers to pay construction and operating costs without hardship. He states that the estimated yearly crop income is $37.50 an acre. He concludes "Because this is regarded as one of the projects best suited to the needs of settlers and appropriate for development under the reclamation law, I recommend its approval."

Fort Snelling-Mendota Bridge Formally Opened

An opening celebration for the Fort Snelling-Mendota highway bridge across the Minnesota River, near Minneapolis, Minn., built for Hennepin County, was held Nov. 8 by representative officials of the state and county. This bridge, with thirteen arch spans of 304 ft., is 4,120 ft. long, with a 45-ft. roadway 120 ft. along the water. It was begun in April, 1924, and has cost about $2,000,000, or $2,400,000 including connecting roads. The bridge, construction of which was noted in *Engineering News-Record* of Sept. 2, p. 370, and Oct. 14, p. 621, was designed by Walter H. Wheeler and the C. A. P. Turner Co., Minneapolis, associated, and was built by the Koss Construction Co., Des Moines, Iowa.

Lakeland, Florida, Starts Building Civic Center Project

Work has begun on the civic center development in Lakeland, Fla., where, during the next year or eighteen months, it is planned to spend $750,000. The money will go largely toward the improvement of Lake Mirror, in converting the entire shore line into a drive or walkways and in building an amphitheatre and recreational and sports grounds.

Three of the new municipal buildings which form a part of this new civic development have already been constructed. They are the city hall, municipal auditorium, and a police, fire and city court building, costing altogether $400,000.

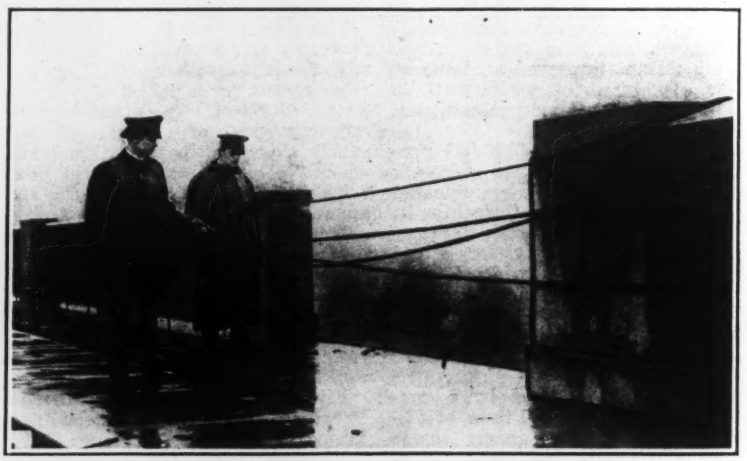
Another Toll Bridge Bought

Purchase of the Portland private toll bridge across the Delaware River by the states of Pennsylvania and New Jersey was approved by the stockholders of the owning company on Nov. 3. The states offered $50,000. This purchase is part of the program of the two states to free the Delaware River bridges, all but one of which were private toll structures up to within a few years ago.

Plan Commission Advocates Road and Harbor Works for Chicago

An elevated road for automobiles through the northwest section of the city, a double-deck street along the north bank of the river and an outer 75-mile boulevard around the city are among the improvements advocated in the annual report of the Chicago Plan Commission. The elevated way would be parallel with and adjacent to the Chicago & Northwestern Ry., relieving the congested traffic of Milwaukee Ave. Inclined approaches would be provided about a mile apart and at the city end the roadway would divide, one part leading south along Canal St. and the other turning west on Illinois St. to connect with the Lake Shore Drive. The river-front street would duplicate the one recently completed along the south bank. In a preliminary report to the Commercial Club by Major R. W. Putnam, U. S. Engineers, who is on leave to study the Chicago harbor problem on behalf of the club, five possible sites have been suggested: (1) near the Illinois-Wisconsin state line; (2) at the municipal pier; (3) between 16th and 31st Sts.; (4) near the Illinois-Indiana state line; (5) in the Calumet district (Indiana). Factors to be considered in the selection include construction cost, convenience for shipping, rail-and-water transfer, etc.

An Instance of Severe Handrail Service—Connecticut Ave. Viaduct Over Rock Creek Valley, Washington, D. C.



THE gap is due to the impact of an automobile, which knocked out a panel of the heavy railing, but fortunately did not go overside itself. The panel was anchored by the stubs of steel rod seen projecting from the floor of the bridge.

Engineering Societies

Calendar

Annual Meetings

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, Columbia, S. C.; Annual Convention, Philadelphia, Pa., Nov. 15-16, 1926.

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 19-21, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, Asheville, N. C., Jan. 24-28, 1927.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 22-24, 1927.

The Ohio Valley Improvement Association held its annual meeting at Paducah, Ky., Oct. 11 and 12, at which it was stated that the canalization of the Ohio River from Pittsburgh to Cairo, with a 9-ft. minimum depth, will be completed in 1929. Provision of rail-and-water terminals was urged by J. F. Froggett, Cleveland, Ohio; and Col. C. W. Kutz, U. S. engineer officer at Cincinnati, presented a paper on American and foreign terminals of this kind. Col. G. R. Spalding, Corps of Engineers, of Louisville, Ky., outlined the present status of the eight locks and dams yet to be completed. Mr. Merrill, Charleston, W. Va., stated that the Great Kanawha River Improvement Association is planning for a 9-ft. stage to correspond with the Ohio River. Addresses were made also by General Edgar Jadwin, Chief of Engineers; General T. Q. Ashburn, chairman of the Inland Waterway Corporation, and Oscar F. Barrett, president of the Ohio Valley Improvement Association.

The Providence, R. I., Section of the American Society of Civil Engineers invited Robert H. Whitten, zoning expert, city of Providence, to present at the section's Nov. 9 meeting his "Proposed Thoroughfare Plan for the City of Providence" which has been developed after comprehensive study of the traffic question in the city.

The Engineers Club of Tucson, Ariz., has elected Bruce B. Ellis, county engineer of Pima County, as president. Other officers are: vice-president, George Foster; secretary, Gorm Loftfield; treasurer, James Macmillan.

The Rochester, N. Y., Engineering Society at its Nov. 8 meeting had an address, "The Engineer in Industry," by George S. Davison, president of the American Society of Civil Engineers.

The Florida Section of the American Water-works Association, will hold its first meeting Nov. 18 in the City Hall, Tampa, Fla., in the office of Anson Squires, local water superintendent.

Personal Notes

H. A. RANDS, formerly construction engineer for the Portland Electric Power Co., has just returned to the United States after spending a year in Nome for the U. S. Smelting, Refining and Mining Co. He is now employed by the Washington Water Power Co., Spokane, Wash., in connection with the Lake Chelan hydro-electric development.

RALPH R. WOOLLEY, Salt Lake City, Utah, a hydraulic engineer, is the editor of the *Utah Engineer*, a new paper published in the interests of engineering in Utah. Mr. Woolley since 1917 has been working with the U. S. Geological Survey classifying public lands throughout the intermountain region as to water power and irrigation possibilities and was at one time assistant engineer in the state engineer's office in Salt Lake City. He had also been connected with road materials tests, and railway valuation, and, besides, other hydro-electric and irrigation investigations.

W. A. BERCAW has been promoted to division engineer of maintenance-of-way on the Chicago, Burlington & Quincy R.R., with headquarters at St. Louis, Mo.; until this promotion he was a roadmaster in Illinois and Missouri divisions of the railroad.

M. A. FOUHY, until rceently connected with Weiskopf & Pickworth, consulting engineers, New York City, has opened an office at 45 West 45th St., New York City, for consulting practice on buildings, industrial plants, power houses and factory construction.

WILLIAM A. JONES, engineer for the water board, Detroit, Mich., was named manager of the recently incorporated village of Huntington Woods, Mich.

WILLIAM M. GREEN, engineer who has been in charge of the investigation of the Great Basin reclamation project in Utah, for the U. S. Bureau of Reclamation, has resigned from the service to go to Mexico on land reclamation work which the J. G. White Engineering Corporation is doing in Mexico for the Mexican government and private interests.

Obituary

GEORGE A. HARWOOD, vice-president of the New York Central Lines in charge of improvements and developments, and the engineer who was in charge of construction of the Grand Central terminal in New York City and of the electrification of the line north to Harmon, N. Y., died Nov. 4 in White Plains, N. Y., aged 51 years. Mr. Harwood was born in Waltham, Mass. He studied both civil and electrical engineering at Tufts College, graduating in 1893, and for two years thereafter was in the employ of the Boston & Maine R.R. In 1900 he went to the New York Central as a draftsman and worked up through the engineering department until in 1906 he became chief engineer of the electric zone improvement at New York City. In 1916 he was appointed engineering assistant to the vice-president, occupying the same position under federal control in 1918, and in July, 1918, was appointed corporate chief engineer, New York Central Lines. In February, 1920, he was appointed assistant to the president, which position he had occupied up until the time of his promotion to the vice-presidency in 1924.

AVEN J. HANFORD, president of the American Toll Bridge Co. which is building the highway bridge across Carquinez Straits, Calif., died suddenly on Oct. 26. Mr. Hanford formed and operated several ferry companies in the San Francisco Bay region and organized and directed the company that built the Antioch bridge opened to traffic early this year. At the recent hearings before the San Francisco board of supervisors he presented a plan for the construction of a bridge across San Francisco Bay.

COL. EDWARD BEACH ELLICOTT, Chicago, Ill., president of the Construction Division Association of veterans of the Construction Division of the Army, died Oct. 26 aged 61. Colonel Ellicott's work was mainly in electrical engineering, in Utah, Kansas, Illinois and Ohio; he was at one time city electrician of Chicago and later electrical engineer of the Chicago Sanitary District.

W. S. WEBB, Burlington, Vt., railroad builder and director, died at his home near Burlington Oct. 29, aged 75 years. Mr. Webb was president of the Wagner Palace Car Co. until its merger with the Pullman Co.; also he was president of the Fulton Chain Ry., the Fulton Navigation Co., the Racquette Lake Transportation Co., and the Mohawk & Malone R.R., and a director in other railway companies, including the former L. S. & M. S.

E. C. DIETRICH, city engineer of Tucson, Ariz., died in Los Angeles, Calif., Oct. 14, aged 45 years. During the World War he held the rank of major in the U. S. Corps of Engineers overseas.

M. L. COOK, former county surveyor of San Bernardino County, Calif., died recently, aged 63 years. He held office from 1894 to 1910.

CHARLES B. ROWLAND, civil engineer and vice-president of the Continental Iron Works, died at his home in Greenwich, Conn., Nov. 1, at the age of 61 years. Mr. Rowland was born in Greenpoint, N. Y., and graduated from the Columbia University School of Mines with the degree of civil engineer. Directly after graduation he became associated with the Continental Iron Works, of Brooklyn, which his father founded in 1859 and where the *Monitor* was built in 1862. He devoted his entire business career to the Continental Iron Works and for the last twelve years had been its vice-president. His father was Thomas Fitch Rowland, who established the Thomas Fitch Rowland prize of the American Society of Civil Engineers.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Used Equipment Dealers Need Manufacturers' Co-operation

Excessive Prices for Repair Parts and Treating Dealers as Competitors Cited as Present Condition

By H. M. Capron
President, Equipment Corp. of America, Chicago

IN over twenty years experience in the construction equipment industry both as a manufacturer of new and an extensive operator in used equipment, I have heard the question of trade-ins discussed from many angles. Invariably the manufacturers agree that the practice is an evil which should be discouraged. Manufacturers generally agree that it is impossible to profitably rebuild their own product, to say nothing of other makes of machinery. The salesman will maintain that a sale has been made that would not have been made otherwise. But the answer is, why make a sale if you make no money? Surely not just for the satisfaction of keeping the other fellow from making a sale. We do not want to be like the chair manufacturer of whom it is said, "He lost money on each chair but he made so many he could afford to."

When the manufacturer has learned by sad experience that trade-ins are poor business and refuses to consider them, an agent sometimes thinks he can handle them himself. Many an agent has had his year's profits tied up in trade-ins and cannot pay his rent. The result has been serious in many cases and a failure has resulted which is bad for the industry.

True Appraisal Necessary

The first mistake is made when the salesman tells the customer his product has a greater trade-in value than other makes. When the trade-in time comes the customer is the seller and he not only remembers what he was told but adds that as it is the manufacturer's own product he can afford to allow more for it than anyone else since he can get repairs at cost. The deal is not closed however, for the customer then calls in a rival salesman and uses the figure backed up by the argument that it is a chance for him to replace a competitor's machine with his product and he can afford to allow more, so the deal is closed and the resulting loss is charged to advertising. *If the machine had been properly appraised by an outsider the value would have been very different and fairer all around.*

Our organization is fundamentally a manufacturing one and we keep our costs like a manufacturing plant. We have very accurate rebuilding costs on most makes and kinds of construction equipment and appraisals are based on these costs. We find that most manufacturers and agents allow more than our cost figures justify and frequently use poor judgment in taking in obsolete models or those physically beyond the point of reconditioning.

It has been suggested that the automobile industry has solved the problem. Perhaps they have for themselves but have they for us? Many a family is getting pleasure riding around in an old car that someone else would not ride in. But in our industry it is different for equipment must make money, and obsolete, worn-out equipment will not do it.

If the manufacturers and their distributors would agree not to make any direct trade-ins we would have some place to start from. Perhaps the first step is for the manufacturers and their salesmen to tell the prospect with a machine to trade in, the exact facts. If his machine has no trade-in value tell him so. This will eliminate a large percentage of the old, out-of-date, worn-out equipment. *If it has real value have it appraised by someone other than the salesman who is trying to make the sale.*

Used Equipment Business Speculative

The article in *Engineering News-Record*, Sept. 30, 1926, p. 560, suggests that perhaps there should be more reliable used equipment dealers in the country. This may or may not be true. The records show that the business mortality is very high among the used equipment dealers. A list of today's dealers contains very few of the names of the list of ten years ago and practically none of those of fifteen or twenty years ago. *The business is highly speculative, partly due to conditions brought about by the policy of the manufacturers.*

There is not enough volume to be had in the business to attract any large amount of capital and instead of there not being enough, there are probably more than enough used machinery dealers to handle the legitimate business of the country. The manufacturers can do a great deal to make and keep them reliable by treating them as allies and working with and through them. *The honest rebuilder of used equipment has a place in the industry and can help the manufacturer to break down sales resistance by doing a good job of rebuilding.* Many have much better facilities for rebuilding than the manufacturer but if they are charged excessive prices for repair parts, the natural tendency is to leave "border-line" parts in, or use home-made parts.

The sentiment expressed by the manufacturers in the article in *Engineering News-Record* is undoubtedly the honest conviction of the majority of the executives, but they forget to pass this information on to their individual salesmen and branch managers. Many of them consider that a used equipment dealer who happens to own one of their machines is a competitor. Their arguments against it only tend to reduce the price, which lowers the resale value of every machine in that territory, of that particular make. If this was better understood reliable rebuilders of equipment could handle more machines of that particular make.

If salesmen representing manufacturers tell the contractor he should get from 50 per cent to 66 per cent of what he paid for his machine, even a contractor who knows his business and has depreciated the article on his books to 10 per cent of the original cost by charging his different jobs the market rental price on a similar piece of equipment, is nevertheless misled as to values.

Dealers and Manufacturers Are Allies

The same salesman then does a right about face, telling his next prospect not to buy a similar piece of equipment from a reliable equipment dealer who has spent probably 33⅓ per cent of the new price honestly rebuilding it. *Manufacturers are all convinced that they are better off if the used equipment dealer will take their old machines off their customers' hands. But by charging excessive prices for their repair parts and going to great lengths to discourage the resale of that same piece of equipment, they are hurting an ally.*

The manufacturers' ideas as expressed in the article are all sound and correct but as each individual case comes up before them they regard it as a special case and the rules which they have formulated from years of experience are broken and equipment traded in at a price that no equipment dealer could touch.

Used equipment dealers have a better market for used machines than the manufacturer because they receive inquiries from clients who could not possibly buy a new machine because of its price. Sometimes their jobs are so small that a new machine is out of the question and they do not ever inquire of the manufacturer because they know they could not possibly pay the new price.

Concrete Road Yardage

For October the square yardage included in concrete pavement contract awards, according to the Portland Cement Association, were: 4,223,517 for roads; 2,967,800 for streets; and 336,451 for alleys; or a total for the month of 7,527,768 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1926

Month	Roads	Streets	Alleys	Total All Classes
Jan....	2,161,415	1,410,201	57,218	3,628,834
Feb....	2,726,611	2,010,941	274,836	5,012,388
March.	4,662,885	3,050,630	224,879	7,938,394
April..	8,758,195	4,324,729	479,763	13,562,687
May...	8,910,678	4,619,195	507,250	14,037,123
June...	10,973,452	5,999,859	524,572	17,317,883
July...	5,662,841	4,865,421	327,313	10,855,575
Aug...	6,594,150	6,293,849	360,991	13,248,990
Sept...	3,736,005	4,342,265	299,350	8,377,620
Oct....	4,223,517	2,967,800	336,451	7,527,768
Totals	58,229,749	39,884,890	3,392,623	101,507,262

Pennsylvania R.R. Orders Electrical Equipment

Following up its program of electrification of suburban lines entering Philadelphia, the Pennsylvania R.R. has placed an order with the Westinghouse Electric & Mfg. Co. for electrical equipment for 93 coaches, to be used on the Wilmington division. In addition, motors and control for four electrical passenger locomotives are included. The Pennsylvania already has 130 of the electric coaches operating on their Paoli and Chestnut Hill branches. Orders for three similar locomotives were placed in 1924 followed by a second order for 6 last February. Each locomotive has a continuous rating of 3,730 hp., will weigh 400,000 lb. and have a total length of 68 ft. The locomotives are of the 2-8-2 type. A sustained speed of 70 m.p.h. is possible. These locomotives will be used on the New York division between Manhattan Transfer and Pennsylvania Station.

Business Notes

VERNON C. WARD, of Chicago, has been made manager of the new junior beam department of the Jones & Laughlin Steel Corporation, Pittsburgh. Mr. Ward for the past 17 years has been contracting engineer of the American Bridge Co. in Chicago. The rapidly expanding business on this new small sized beam requires enlargement of the distributing and sales forces, and has led to the creation of the new department and to Mr. Ward's appointment, it is said.

AMERICAN STEEL & WIRE CO., Chicago, has decided to enlarge its Birmingham sales office in order to serve the trade and cover all the products manufactured by the company. J. J. Gilmore, heretofore in charge of the office, has been promoted to manager of sales with an office force and sufficient traveling representatives to keep in close and frequent communication with the trade in the Birmingham district. The Birmingham office is now recognized as a unit of the general sales office in Chicago.

J. R. BRANDT has joined the Cleveland office of the Bridgeport Brass Co. as a salesman for raw material in the Pittsburgh territory and parts of Ohio.

PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., announces that Lee & Clark, 549 Washington Boulevard, has been appointed as its representatives in the Chicago district.

SULLIVAN MACHINERY CO., Chicago, announces the appointment of J. E. M. Schultz as manager of its Dallas, Texas, office. Mr. Schultz has had long experience with the company, having been associated with its office at Knoxville, Tenn., in charge of business in North and South Carolina, Georgia and Florida. He takes the place of D. H. Hunter, who has resigned.

WALTER S. MILES, contracting engineer, Virginia Bridge & Iron Co., Roanoke, Va., will be in charge of the recently established New York office of the company at 2 Rector St. Mr. Miles was formerly located at the Tampa office of the company.

V. W. CODDINGTON has been appointed chairman of the board, Lakeside Bridge & Steel Co., North Milwaukee. Other appointments are S. C. Coddington, president; C. G. Margwarth, vice-president and treasurer; H. M. Risseeuw, vice-president and general sales manager; and W. H. Genske, secretary.

G. H. WILLIAMS CO., Erie, Pa., announces that a reorganization of the management has just been effected in which W. W. Cochrane becomes general manager, J. D. Harter, sales manager, C. D. Buoy, chief engineer and H. H. Neeve, superintendent.

TIMKEN ROLLER BEARING CO. is spending one and a half million dollars in expanding its Canton, Ohio, plant. Construction is under way and the new units are to be completed by January 1, 1927. The construction includes provision for large laboratory and research facilities.

E. C. NEACY, formerly associated with the Beaver Mfg. Co., has been appointed manager of the contractors equipment division of the Independent Pneumatic Tool Co., Chicago.

New Developments

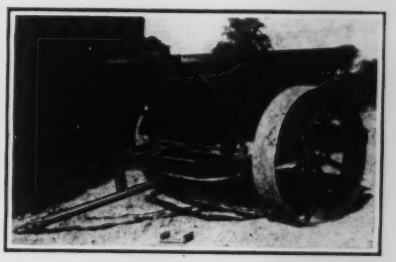
Cast Iron Headwalls Used for Corrugated Cast Iron Pipe

Advantages of quick installation, permanent structure, reduction in labor cost and complete salvage are claimed for the cast iron headwall developed by the American Casting Co., Birmingham, Ala., to be used with its spiral corrugated cast iron culvert pipe. The illustration shows one of these installations on Highway No. 31 near Waco, Texas.

The headwall is shipped in five pieces with two small keys to lock the whole into place. Each set is made up of two complete headwalls, one for the upstream and one for the downstream end of the culvert. The five parts consist of a lock ring, back wall, side aprons, and a bottom apron. The bell of the lock ring passes through a hole in the back wall and is screwed into the spiral pipe. The side aprons are made right and left hand and of such shape as to give the desired flare to the headwall. The bottom apron is not shown in the illustration but is fastened to the side aprons by means of a double dovetailed cast iron key. The connections are so designed that pressure of the backfill tends to tighten the joints rather than to weaken them.

Welded Steel Dump Trailer

The accompanying illustration shows an all-purpose heavy duty trailer recently brought out by the Euclid Crane & Hoist Co., Euclid, Ohio. It is designed for one man operation behind a tractor. Electric welding is used in place of riveting on the frame while



the body itself is entirely welded making it water tight and suitable for the transportation of grout. The type of welded joints used throughout the construction of the equipment were developed through co-operation with the research department of the Lincoln Electric Co., Cleveland, and by field service tests.

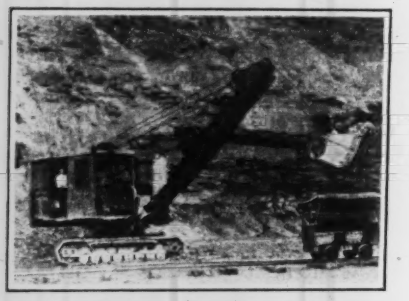
New Electric Shovel Uses Air-Operated Hoist Clutch

An electric shovel with an air-operated hoist clutch, convertible to crane or dragline, has just been put on the market by the McMyler Interstate Co., Cleveland. It may be placed on crawler, tractor wheel or railroad car mountings. The 1-yd. manganese steel bucket is driven by a single chain-and-sprocket crowd. A sprocket at the base of the boom drives the chain, enabling the boom angle to be changed without adjustment of the chain. The chain crowd enables the operator to shake the dipper without losing spotting accuracy. This is claimed to give the shovel extra ability to handle wet, very wet and sticky materials.

The compressor driven by the main motor supplies air to a storage tank connected to the hoist clutch ram. The use of the air-operated hoist clutch is claimed to relieve the operator of much of the hard labor required with the usual manual friction type clutch. All operations of the shovel are actuated by the 60-hp. motor. It is claimed that the full power of the motor is available for any of the operations.

Equipped with a 17½-ft. boom and a

14½-ft. dipper stick, the shovel has a maximum digging radius of 27 ft. 11 in., dumping radius of 25 ft. 5 in., digging height of 20 ft. 5 in., and a dump-



ing height of 19 ft. 6 in. It may also be equipped with a 20-ft. boom and a 16-ft. 4-in. dipper stick. The operating weight of the shovel with crawler car body as illustrated is 69,500 lb., giving a soil pressure of 12½ lb. per sq.in.

New Publications

Snow Plows—GOOD ROADS MACHINERY CO., INC., Kennett Square, Pa., has issued a 50-p. catalog treating in detail the problem of snow removal and the use of its several different types of plows for this purpose. Illustrations are used both of details of the plows and of the equipment under actual working conditions. Specifications as well as general descriptions are given for each type of plow. Two pages in the back of the book are devoted to a list of some of the users of the company's snow plows.

Small Rail Crane—THE PARSONS CO., Newton, Iowa, has issued an 8-page bulletin describing its new rail crane operated by a gasoline engine and running on the railway track. The bulletin describes the crane, giving statistics on the saving to be effected by its use, in addition to other advantages claimed for it. A number of illustrations are given showing its use on various railroading operations. Complete specifications for the equipment are given.

Power Shovel—OSGOOD CO., Marion, Ohio, has issued a 24-page booklet No. 2620 describing its 1-yd. gas or electric shovel. Illustrations of all of the important machine details, together with descriptions of them, in addition to tables and line drawings of capacities and working ranges, make up the subject matter of the book. Several pages of construction views are given.

Concrete Regulation—J. G. AHLERS, 110 West 40th St., New York City, has issued a pamphlet describing his concrete strength regulator which automatically applies a predetermined water-cement ratio in mixing concrete. The pamphlet describes the regulator, states its advantages and explains in detail the theory and manner of its operation.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Detail Replacement Costs of an Office Building Erected in 1914

This is the first of a series of articles comparing the cost today of the component materials and labor of various typical structures built in 1914. The 1914 figures are based on data furnished by F. E. Barnes, chairman of the New York-Pittsburgh Association of Valuation Engineers, which is a sub-committee of the President's Conference Committee of the railways of the Eastern district. The 1925 figures are computed by applying current unit costs to the actual quantities that make up the building.

THE first structure chosen for a comparison of 1914 with 1925 costs is a typical steel and brick nine-story office building—177 x 58 ft. in plan and 114 ft. high—located in Philadelphia. Plumbing, heating, lighting and elevators are excluded. The table gives the actual amount expended on each item in 1914 and the 1925 replacement values, together with the proportion that each bears to the total cost.

There is not a single group that has not increased in price, but some have increased more than others. Steel and stone are by far the most important materials, the two of them combined aggregating about half of the total materials cost. Brick, lumber and cement are the next in order of importance.

Brick has shown the greatest increase in price, jumping from 9.8 per cent of the total material cost to 14.6 per cent. The actual price per thousand of common brick has almost tripled since 1914.

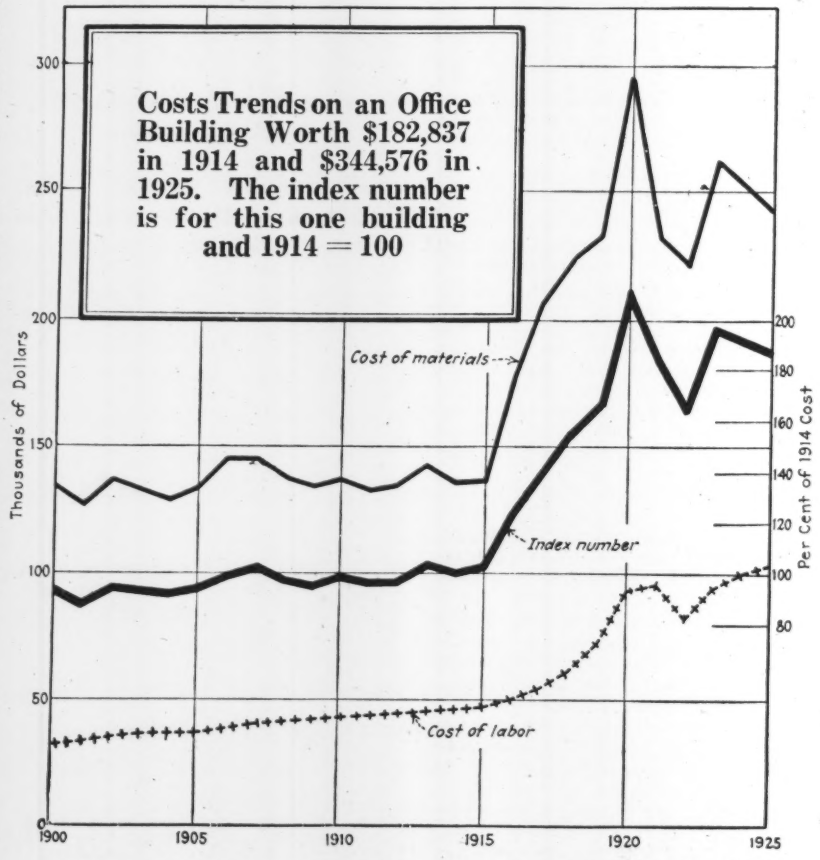


CHART I—MOVEMENT OF COSTS DURING LAST TWENTY-FIVE YEARS

Estimated Average Cost of Typical Office Building 117′ by 58′ and 114′ High

Materials	1914 Amount	1914 Per Cent of Total Material Cost	1925 Amount	1925 Per Cent of Total Material Cost	Relative Increase (+) or Decrease (—)
Brick	$13,376.38	9.77	$35,366.84	14.60	+4.83
Lumber	12,408.02	8.91	23,043.72	9.53	+0.62
Flooring	4,300.69	3.15	8,801.05	3.63	+0.48
Cement	7,603.20	5.56	15,321.60	6.32	+0.76
Reinforcement	1,956.18	1.43	3,773.91	1.56	+0.13
Paint	2,079.10	1.52	4,566.13	1.90	+0.38
Sand and gravel	4,630.00	3.38	8,100.38	3.34	—0.04
Metal work					
Lath	733.32	0.54	1,257.12	0.51	—0.03
Copper	2,014.57	1.48	3,009.82	1.24	—0.24
Iron	2,160.87	1.58	4,329.40	1.79	+0.21
Steel	40,438.04	29.55	60,167.88	24.94	—4.61
Stone	34,201.87	25.00	54,802.26	22.63	—2.37
Tile	4,372.63	3.19	6,067.77	2.51	—0.68
Miscellaneous	2,037.64	1.48	5,675.90	2.34	+0.86
Compensation to sub-contractor	4,730.25	3.46	7,661.42	3.16	—0.30
Total	$137,042.76	100.00	$241,945.20	100.00	

Labor	1914 Amount	1914 Per Cent of Total Labor Cost	1925 Amount	1925 Per Cent of Total Labor Cost	Relative Increase (+) or Decrease (—) of 1925 over 1914
Bricklayer	$10,333.83	22.01	$22,708.69	22.12	+0.11
Carpenter	5,966.82	12.71	13,385.39	13.04	+0.33
Engineer	1,383.47	2.95	2,855.32	2.78	—0.17
Painter	3,686.96	7.82	8,587.47	8.38	+0.56
Plasterer	2,810.64	5.97	6,525.45	6.36	+0.39
Stone mason	1,215.82	2.59	2,480.66	2.41	—0.18
Laborer	12,487.72	26.61	28,281.06	27.56	+0.95
Miscellaneous	3,670.60	7.82	7,720.42	7.52	—0.30
Machines	4,330.14	9.23	7,962.60	7.76	—1.47
Compensation to sub-contractor	1,028.29	2.29	2,123.64	2.07	—0.22
Total	$46,914.29	100.00	$102,630.70	100.00	.....
Material plus labor	182,837.05		344,575.90		
Per cent of total cost:			1914	1925	
Material			74.4	70.2	
Labor			25.6	29.8	
1925 increase over 1914= 188.46					

The other relative increases have all been less than 1 per cent. Steel has dropped 4.6 per cent and stone 2.4 per cent. Steel and stone combined were 40.6 per cent of total construction cost in 1914, while in 1925 they were only 33.3 per cent.

On the labor side, there are no such marked changes in proportion. Common labor has increased its relative importance by 1 per cent, while the cost of machines show a relative decrease of 1.5 per cent. But the cost of labor as a whole tends to absorb more and more of the total construction cost. In 1914 it was only 25.6 per cent of the total cost, whereas in 1925 it had jumped to 29.8 per cent. In 1900 labor was only 18.4 per cent of total cost.

Charts I and II bring out this tendency very clearly. The heavy line on Chart I is the index number of the construction cost reduced to percentages of 1914. The broken line is the actual labor cost and the light black line is the actual cost of materials. Prices of materials fluctuate much more than the prices of labor, indicating a more sensitive relation to the ratio of supply and demand than labor does.

Chart II shows the gradual increasing proportion of the labor cost to the total construction cost. The low proportion from 1915 to 1920 is due to the tendency of wages to lag behind prices as a whole. In 1921 when there was a big decrease in cost of materials, labor took a jump which put it well above its 1915 proportion.

About every three years there has been an increase of 1 per cent. Just how long this tendency will continue is very difficult to predict, but as yet it shows no tendency to slow up.

DESCRIPTION OF BUILDING
Philadelphia, Pa.

FRAME—Steel Floor Beams and Girders Encased in Store Concrete. Interior Columns Encased in Building Tile. Exterior Columns Built in Wall.
EXTERIOR WALLS—Brick-Faced With Face Brick. Limestone Trim.
FLOORS—Stone Concrete Slab With Wood Surface in Offices and Mosaic Surface in Corridors.
ROOF—5 Ply Slag.
INTERIOR—Walls Furred with Building Tile, Partitions of Building Tile. Finish: Plaster, Painted White Lead and Oil. Entrance Hall: Marble Walls and Ceiling. Corridors: Marble Wainscot.
MILL WORK—Oak.
ELEVATORS—Two-Passenger.

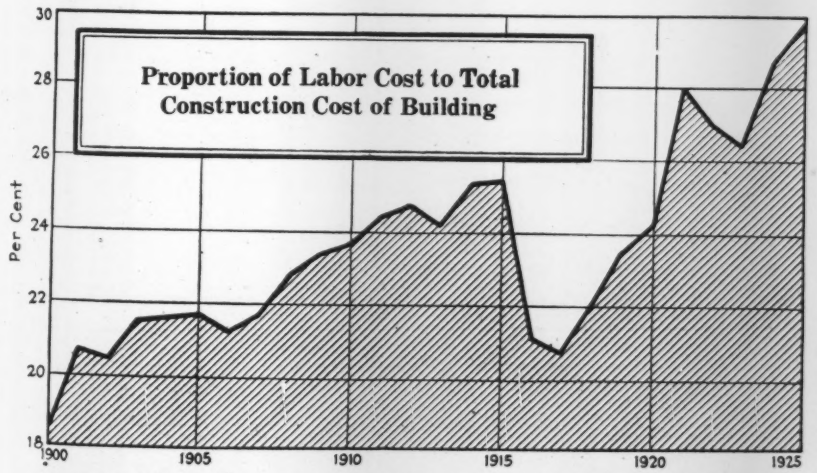


CHART II—RELATION OF LABOR COST TO TOTAL CONSTRUCTION COST

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
Nov. 11, 1926	$14,843,000	$54,965,000	$69,808,000
Nov. 4, 1926	11,263,000	36,486,000	47,749,000
Nov. 12, 1925	13,866,000	35,810,000	49,676,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date:			
	Public	Private	Total
1926	962,217,000	1,575,548,000	2,537,765,000
1925	936,195,000	1,293,085,000	2,229,280,000

Steel Production Continues at High Rate

The output of steel ingots in the United States for the month of October was heavier than that for the same month last year, despite recent reports of recession in the steel industry.

The gain this year, over September was 4 per cent, compared with a 11 per cent increase in October, 1925, over the month preceding.

The year 1926 will probably come out about three million tons ahead of 1925. Reserve materials stocks are small, therefore this steel must be going into industry, construction particularly. Following are the monthly tonnages as calculated by the American Iron & steel Institute:

	1926 Tons	1925 Tons
January	4,150,469	4,193,281
February	3,801,776	3,752,352
March	4,488,362	4,194,340
April	4,123,941	3,583,676
May	3,945,336	3,454,971
June	3,750,653	3,204,451
July	3,651,055	3,084,472
August	4,004,583	3,420,998
September	3,930,675	3,489,565
October	4,092,548	3,888,814
10 Months	39,939,398	36,266,920

Weekly Construction Market

THE present slight upward turn in general wholesale prices is shared by building materials as a group but in the case of the latter, the movement is not entirely seasonal.

Present construction costs are about 0.4 per cent above a month ago and 2 per cent higher than in November, 1925. Approximately 53 per cent of the total cost, however, is represented by labor.

Tendency toward price weakness appears greatest in lumber and the basic materials other than brick and steel.

Steel is the most important single item on the list at the present time. Export demand for fuel due to the British coal strike and recent wage advances to American miners have combined to raise the price of pig iron.

Thus far, the effect upon finished steel has amounted to nothing more than a slightly increased firmness at levels prevalent during the last few months. Surplus stocks of iron are not large.

Aside from a sustained demand for rails and a slight improvement in heavy melting scrap, the market is slow in the principal steel items. Decreased volume of buying is especially noticeable at present in steel plates, shapes, bars, pipe, strips and sheets.

Compared with the last week in October, higher prices for aggregates are now being quoted in Chicago and for brick in Atlanta. Declines occurred in reinforcing bars at Chicago, lime in Atlanta, clay products in the New York district, and linseed oil at Denver, New York, Minneapolis and Chicago.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$3.75
Structural rivets, 100 lb.	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	51%	54.25%	41%	49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@52.60	45.25	54.00	48.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	+1.85	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd.	1.00	1.60	2.00	+1.65	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	40.50	38.75	34.75	27.00	23.00	65.00
Lime, finishing, hydrated, ton	18.20	—22.00	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00—1.40	1.82	1.50	1.70	2.70	1.60	2.80	10.00	
Common brick, delivered, 1,000	20.40@22.40+12.00	14.10	12.00	13.75	9@10	15.00	15.00	20.25	
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.088	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1027	.0895	.112	.088	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb gal.	—.84¾	.99¾	1.10	—.85	—.93¾	—1.05	1.01	1.12	1.05
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	.90	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.60	.40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Nov. 4 the next on Dec. 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5⅓ x 8 x 11⅓. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.14). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) carload lots; shapes, l.c.l.

Business Briefs

Call money quoted at 4½ per cent, Nov. 9; year ago, 4½ per cent.

Time loans: 60 to 90 days, 4⅜; 4 to 6 months, 4¾ per cent.

Commercial paper: Best names, 4@6 mo., 4½; others, 4¾ per cent.

On Nov. 1, 1926

E. N.-R. Construction Cost Index Number 210.80

E. N.-R. Construction Volume Index Number 244

For Explanuation and Details of Indexes Since 1913 See the First Issue of Every Month